ARMY ORDNANCE

The Journal of the Army Ordnance Association—Now in its Nineteenth Year of Publication. Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guaranty of Peace

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The Army Ordnance Association

THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guaranty of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency, time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

The Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace insurance" in this form is the foremost aim of the Army Ordnance Association.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application on request.)

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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A School of Supply Strategy

The Aims and Methods of the Army Industrial College

By Col. Harry B. Jordan*

THE Army Industrial College was established by General Orders No. 7, War Department, dated Washington, February 25, 1924. Its mission is to train officers of the Army, Navy, and Marine Corps along lines which will prepare them for performing the function of supervising the procurement of all military supplies required in time of war. Furthermore, the college will equip them with the knowledge needed to assure that adequate provisions are made for the utilization of the national resources in matériel, industrial facilities, and services essential to meet the needs which war creates. Col. Dwight F. Davis has stated that of all his official acts which he took while Assistant Secretary and later as Secretary of War, no other ranked in importance with this.

THIS article by the distinguished director of the Army Industrial College is timely. The subject is of special meaning because the idea and ideal of the college in the furtherance of industrial preparedness are constantly growing. As a school of the Army, the Industrial College is of highest importance among all the educational institutions conducted by the military establishment, its curriculum is of far-reaching significance, its training is of the very essence of modern military defense. The country should know what this graduate school means to our national security. The day has come when this institution should be accredited for what it is in the training of our military and naval personnel.

Such an estimate demands an ample basis of fact—else the appraisal is worthless. This basis is not difficult to state. Briefly it is: If our commanders of both services in future do not know the principles of industrial mobilization—in detail and by conviction—then American leadership at best will be mediocre. And mediocre leadership has nothing more than a nuisance value.

The Army Industrial College deserves—and its friends will insist—that its influence be broadened, its student body expanded and its doctrines freely arrived at. Moreover, it now seems appropriate to suggest that adequate facilities for this great school be made available. As in the academies of old, master and scholar think best when facilities are adequate for teaching the doctrine and for learning it.—EDITOR.

The preparation for and the conduct of modern war embraces two important elements: (1) The preparation of plans for procuring suitably equipped men and the actual procurement of these men; (2) The preparation of plans for procuring the needed matériel and services and the actual procurement of such matériel and services.

The following quotations emphasize this lesson and in no uncertain terms prove the value of matériel supply if personnel is to be used properly in time of conflict:

"The three or four months' period immediately following our entrance into the war of 1917, to one near the center of power in the War and Navy Departments, created somewhat the effect assigned by observers to a peek into the crater of an active volcano. The general impression was chaos.

"'All work was done at a furious rate, amid countless interruptions, ceaseless alarms, and the wildest public confusion. Every one wanted to fight; few were willing to recognize that war calls first of all for ordered preparation. The public seemed to think that arms and ammunition and all the equipment of an army could be provided instantly and by magic and all that was needed was the word to go forward and overhelm the enemy.'

"The paragraph immediately quoted above is from Douglas Freeman's great book, 'R. E. Lee.' It was written to portray the conditions under which Lee did his work as commander in chief of the forces of Virginia in Richmond in 1861. It accurately describes conditions in Washington, April to July 1917."

The above is from an address by Col. Frank A. Scott, first chairman of the War Industries Board, at one of the graduation ceremonies of the Army Industrial College.

Maj. Gen. Sir Frederick Maurice, British Army, in his book, "Statesmen and Soldiers of the Civil War," writes:

"In his address on July 4, 1861, Lincoln said: 'One of the greatest perplexities of the Government is to avoid receiving troops faster than it can provide for them'—a perplexity with which Kitchener was faced in 1914, and one which must confront every statesman and soldier called upon to develop national strength for war, if measures for that development have not been systematically prepared beforehand."

The Chief of Staff of the United States Army, Gen. Malin Craig, in his annual report for 1936, states:

"In a national emergency there will be an urgent need for the immediate and uninterrupted flow of munitions to the troops. To insure this involves industrial preparedness. To this end the War Department must keep up to date at

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all times accurate estimates of the items necessary for our forces at various stages of mobilization. Our great industrial activities must be kept informed of specifications required. I regard this as one of the most important phases of our scheme of national defense. Without the supplies necessary for our forces, trained personnel, however numerous, will be of little avail in time of conflict." In other words, these three quotations show that military science is specifically divided into two parts: The tactics and strategy of personnel, and the tactics and strategy of matériel.

WE know that in the World War the Army sailed overseas largely in Allies' ships, and to a great extent fought the war with certain vital items of arms and equipment purchased from the Allies. There was confusion and skyrocketing of prices due to shortages, actual or alleged, and bidding against one another by the Army, the Navy and the Shipping Board and, worse still, by the supply services of the Army among themselves. The President called in men prominent in the economic life of the country, and in an effort to bring order out of confusion and to accelerate the industrial effort in support of the military, organized the War Industries Board with practically dictatorial powers. One result of the failure of the Government to plan for World War procurement was the spending by the Government not of millions but of billions of dollars more than would have been spent had planning been done in advance.

As a result of these facts, at the close of the war, Congress, dissatisfied with the system that had been followed, began investigating and legislating along procurement lines. It took away the supervision of procurement from the General Staff and placed it in the hands of a civilian—the Assistant Secretary of War. The action was based on the theory that activities relating to large-scale procurement required a great deal of business experience and knowledge, and should therefore be handled by an individual prominent in the business world—a manufacturer, a banker, or a civilian recognized as a leader in some other section of the business activity of the nation.

The National Defense Act stands out as one of the wisest, best thought out pieces of legislation any Congress ever has passed. For the first time we have specific recognition and definition of the relative positions of the three components of our Army—the Regulars, the National Guard, and the Reserves, and the specific division of the functions relative to matériel.

The functions relative to matériel are as follows: (1) What matériel shall be procured; (2) When it shall be procured; (3) How it shall be procured; (4) Where it shall be turned over to the Army personnel ready for use. The first, second, and fourth functions are clearly and definitely of a nature calling for General Staff supervision; the third is definitely a function and responsibility of the Assistant Secretary of War.

Section 5a of the National Defense Act assigns two duties to the Assistant Secretary of War: (1) Supervision of procurement activity of the War Department (the tactics of matériel); (2) The assurance of adequate provision for mobilization of matériel and industrial organizations essential to war-time needs (the strategy of matériel). These two duties, while distinct, are closely related. The first is the supervision of the supply arms and services in the preparation of the plans they currently prepare covering the ways and means for procuring, in time of war, all items of Army requirements. These plans are to be carried out by the same agencies which make them; for example, the Ordnance Department will carry out the procurement of the munitions in war which are planned for in peace.

IN contradistinction, the industrial-mobilization plans to insure adequate provision for matériel and industrial organization are prepared in the Planning Branch of the Office of the Assistant Secretary of War in collaboration with the Navy through the Army and Navy Munitions Board. It is not contemplated that the agencies just named will carry out these plans, but that the plans will be placed in operation by civilian superagencies to be created by the President under the war powers inherent to his office—war powers granted him by the Constitution, or pursuant to the provisions of special acts of Congress.

The prepared plans may or may not be accepted by the superagencies. They represent the best thought now available; they are in the nature of guides and are subject to change to meet such changed conditions as the future may impose. It is impossible to say in advance just what changes may occur in these plans or who will execute them. Much will depend upon the personality of the President, the temper of the Congress, and the psychology of the people at the time. Meanwhile, it is the job of the Army and Navy to keep these plans for a superagency—a war resources administration—up to date and ready to submit to the consideration of Congress and the President at any moment.

In May 1917, when the Selective Service Act was passed, Gen. Leonard Wood made an historic remark when he said: "This (the Selective Service Act) is only the smaller part of the job. Man power is assured, but the greater problem of munitions has scarcely been touched."

Section 5a of the National Defense Act for the first time gave us an authorized program of planning for industrial preparedness which is carried on concurrently and in close coöperation with the purely military phases. Prior to the National Defense Act, our planning activities had been directed toward facilitating the processes required to convert trained, partly trained, or untrained individuals into units organized and prepared for military employment. However, we failed to appreciate the fact that men could be called to the colors, organized, and trained at a rate far in excess of that at which essential munitions could be made available to them from the economic resources of the nation.

During the initiation of these procurement-planning and industrial-mobilization planning activities, very few individuals had any adequate conception of the scope of the task and the problem involved. It was necessary to make many preliminary studies of the work of the War Industries Board, the Purchase, Storage and Traffic Division of the War Department General Staff, and the organization of industry and its relation to the armed forces in the World War. To secure better coöperation with the procurement services, it was necessary to secure a flow into those services of officers who had a basic knowledge of the principles of industrial mobilization. Thoughtful men studying the underlying concepts of military operations appreciate the fundamental importance of prearrangements for munitions in sufficient quantity and, what is equally important, in sufficient time.

The mere rate at which the nation's man power can be enrolled and trained no longer provides a safe basis for defense plans. Never forgetting that man—the trained soldier—is the primary instrument of battle, the military student realizes that no matter how able the man, he is helpless in military operations without munitions.

WHEN the Assistant Secretary of War undertook to perform the duties given him by the National Defense Act, he found few officers with any conception of the work he was called upon to do. For this reason, previously stated, the Army Industrial College was established in 1924 to prepare officers for these duties. The first class at this college consisted of 9 officers, all from the Army; the seventeenth, the present one, consists of 48 Army officers, 9 of whom are line officers; 6 Navy officers, and 2 Marine Corps officers. The faculty consists of 8 officers—a director and 7 instructors; all are graduates of the Army Industrial College; 4 are graduates of the Harvard Graduate School of Business Administration, and 3 are graduates of the Army War College.

In addressing the Army War College on December 9, 1925, Col. Dwight F. Davis said:

"Experience has shown that in order to meet an emergency it is necessary to train personnel in the problems pertaining to the mobilization and utilization of the nation's matériel resources as well as the nation's man-power resources. The two activities are in a great measure distinct problems, and the best result should be obtained by maintaining separate training systems so that each can specialize upon its particular problems. Each activity must, of course, have general knowledge of the other so that proper coördination can be effected. With this idea in mind, there has been established the Army Industrial College to assist in educating selected officers from the various supply branches in the great problems incident to procurement. It has a mission in supply preparedness analogous to that of the War College in man-power preparedness. It must train officers to man the key positions in the organizations necessary to supply the Army."

The present allotment of students from the various services and arms is as follows: Quartermaster Corps, 9; Ordnance Department, 9; Air Corps, 9; Engineer Corps, 4; Medical Department, 2; Finance Department, 2; Signal Corps, 3; Chemical Warfare Service, 2; Coast Artillery Corps, 2; Infantry, 2; Field Artillery, 2; Cavalry, 2; Judge Advocate General's Department, 1; Navy, 12; U. S. Marine Corps, 2.

In nominating officers of the Army for attendance at the college, selections are made from one of the following three groups: graduates of the Army War College; graduates of the Command and General Staff School with General Staff eligibility, and officers of outstanding ability possessing special qualifications for Army Industrial College training. The officers must have a general rating of not below "excellent." They must have expressed a desire to attend, must be recommended by their chiefs, must not be below the grade of captain, and must be within the age limits. Officers of the line are required to be of outstanding ability and to have demonstrated qualifications for duty of a General Staff nature.

It is not the intention in connection with line students ever to use them on straight procurement duty but rather to give them a desirable background to the end that, when later on they serve tours on the War Department General Staff, they will have a proper appreciation of the problems of industrial mobilization and will not make plans or call for requirements beyond the possibilities of industry. In other words, a leaven of line officers is provided who will have the proper appreciation of the problems which industry faces in providing the armed forces with needed supplies and equipment.

Duty assignments of Army graduates of the Army Industrial College generally have been limited to details in the Office of the Assistant Secretary of War for duty in the Planning Branch; on the staff of the Army Industrial College; in the Current Procurement Branch; in the offices of the chiefs of supply arms and services; in the procurement districts of the supply arms and services, and on the staffs of the general and special service schools. In my opinion, these assignments, while sound and of obvious importance, do not comprise the full use to which Army Industrial College graduates can be advantageously employed. For instance, in the War Department General Staff at least one officer in G-1 should possess the background which will assure a sound coördination of the man-power needs of industry and the armed forces; one officer in G-2 should supervise foreign studies on industrial mobilization and economic resources; one officer in G-3 should coördinate mobilization and procurement plans; one officer in G-4 should coördinate requirements, storage, and issue with procurement; one officer in the War Plans Division should supervise studies in economic strangulation in strategic resources; one officer should be located at each of the American embassies as an assistant military attaché for economic and industrial-mobilization studies (this has partially been done); one officer should be employed in the G-4 Division of the General Staff at each corps-area headquarters to handle corps-area mobilization supply plans without conflict with War Department procurement plans.

THE Army Industrial College is located in the Munitions Building, Washington, D. C., where it occupies a floor of one wing. The accommodations are ample for the purpose and possess one outstanding and invaluable advantage in the activities of the college: We are among the services—it takes only a few moments to go to any one of the Army services or Naval bureaus to secure the advice or the information we desire. The college thus is kept closely in touch with the activities of the services of the Army and the bureaus of the Navy. Our contacts with the Navy are among our most valued possessions and the attendance of Naval officers at the college has done more to promote a mutual understanding of our combined Army and Navy matériel problems than any other one thing that has occurred in years. To know and appreciate the troubles and the difficulties of the other service is the opportunity that few officers except graduates of the Army Industrial College have.

The college has one of the best libraries on industrial subjects, pertaining to the activities we are studying, in existence in the United States. The library, through its connections with the Congressional Library, the library at the Army War College and other governmental libraries located in Washington, is able to furnish to the students source material available in very few, if any, other locations in the United States.

The Army Industrial College enjoys the unique distinc-

tion of being the only institution of learning of its kind in the world today, or any other day. The significance of our country's practical preparations toward assuring the swift coördination of her vast industrial strength in support of any military effort which may arise, must have its proper effect on other countries.

THE policy guiding the curriculum of the Army Industrial College has been broad and foresighted. Most helpful coöperation has been effected with the dean and faculty of the Harvard Graduate School of Business Administration from the start. A group of prominent educators and leaders in World War procurement have been available for consultation. The records of the War Industries Board have been available for our inspection. The ablest lecturers in this country come each year at their own expense, giving freely of their time and thought as a contribution to national defense. Educators, economists, and authors help to build up adequate knowledge, while industrialists, financiers, and officials advise regarding sound technique.

Under the method of instruction followed, the student officers are engaged in research work and the preparation of reports, either individually or in committees, for the entire ten months. Thus the Army Industrial College has become an important center of economic research for the War Department and to a more limited extent for the Navy Department. Each year the research made by students, reduced to the form of reports, is made available to interested agencies, such as the Planning Branch, Office of the Assistant Secretary of War; the supply arms and services, and, where applicable, the War Department General Staff and the Navy Department. These studies have been found to be of outstanding value.

The course divides itself into four parts: Business Administration, Procurement Plans, Industrial Mobilization Plans, and a thesis: "Utilization of War Resources." The course of study in business administration covers economics, statistics, finance, accounting, and industrial problems. These fundamentals are followed by studies covering twelve of our basic industries. During this period some of our outstanding leaders of industry have lectured from our platform, among them Mr. E. J. Sadler, vice-president of the Standard Oil Company of New Jersey; Mr. J. H. Kindelberger, president, North American Aviation, Inc.; Mr. George A. Sloan, president, George A. Sloan & Company, and former president of the Cotton Textile Institute; Mr. W. S. Tower, executive secretary, American Iron and Steel Institute; Mr. W. S. Gifford, president, A. T. & T.; Mr. W. S. Knudsen, president, General Motors.

Next follows "Procurement Plans." The course proceeds with an historical study of World War procurement with its many problems and troubles, and the present War Department and Navy Department organizations for procurement. There then follows a group of problems covering subjects which are under constant study, not only by the Planning Branch of the Office of the Assistant Secretary of War, but also by the services themselves. Some of the most important of these problems are: personnel for procurement, corps-area procurement and supply, industrial war load and allocations, utilization of the automotive industry, war contract procedure, construction in war, ships and shipping, strategic and critical materials.

THE course then covers a prescribed test of the War Department Industrial Mobilization Plan as far as munitions are concerned. Next follows industrial-mobilization planning. This study deals with war procurement and the organization of our Government in all its ramifications. These problems are followed by a group of committee problems, among which can be mentioned: war powers of the President, industrial-mobilization plans, transition from peace to war, licensing of industry, trade organizations and regimentation, budgetary control, control of iron and steel, neutrality, war trade, war labor, war finance, communications, transportation, power and fuel, priorities; price, profit, and production control.

Every problem presented to the students is a live, vital subject—one which the faculty of the Army Industrial College, or the Planning Branch, or the services, or the War Department General Staff, or the Navy has suggested. The worth-while reports on these problems are submitted to the appropriate agencies of the War and Navy Departments. It is pertinent here to state that some of the reports submitted last year were masterpieces in their conception and execution. This estimate of their worth is held not only by the college but in reports received from interested agencies concerned.

In the thesis, "Utilization of War Resources," the student finally is given a chance to present his personal conception of what the super control agency over industry in war should be. These studies also have been of outstanding value.

Before the completion of our course, the student is given a chance to visit the industrial plants in Pittsburgh, Pa., which are so outstanding in the part they must play in a major emergency.

The following paragraph from a recent memorandum of the Chief of Ordnance exemplifies the services' appreciation of the importance of procurement planning: "I am convinced that war planning is one of our most important functions. Indeed, it is one which forms the basis of our other functions, and procurement planning for us is one of the most important elements of war planning."

An officer versed only in the strategical studies of men and of fighting equipment still lacks that intimate knowledge of procurement problems and industrial-mobilization problems which he must have if he is to temper and consider properly his demand on industry in a major emergency.

The Hon. Swagar Sherley remarked in a lecture not long ago: "Our country will never stand in peace time for appropriations necessary for proper preparedness. We shall and always will be unprepared when the emergency comes."

All of this demands that our plans shall be well thought out, well prepared, and kept up to date, and that our reservoir of trained officers from the Army Industrial College, both supply and line officers, shall be ample and instantly available to provide the necessary direction and supervision of procurement of the munitions our man power will require. The writer knows and appreciates the work the students at the Army Industrial College are doing. He knows the grasp the graduate has on the problems incidental to our procurement planning and our industrial-mobilization planning, and without any reservation whatever desires to state that every graduate of this college definitely has become a real asset to his country, and that in case we ever have another major emergency his services are going to be of inestimable value to the United States.

The Fighting Airplane

Will Multiplace Ships Challenge the "Flying Fortress"?

By Horace J. Alter*

IN 1923, the Hague Commission on International Law drew up, with the approval of the major powers, a set of rules and regulations on aërial warfare. Chapter IV—on hostilities—deals with treatment of crews of aircraft and rules governing aërial bombardment. Concerning the latter, Article 24 states: "Aërial bombardment is legitimate only when directed at a military objective; that is to say, an object of which the destruction or injury would constitute a distinct military advantage to the belligerent."

Military objectives are classified as military forces, military works, dumps, depots, factories engaged in the manufacture of arms, ammunition, or military supplies of any kind, forts, communication lines, transportation lines—and what have you? In fact, there is very little that cannot be considered a military objective. The laws state that cities, towns, or buildings not included above and not in the zone of operations must not be bombarded. However, there can be no doubt that bombardment airplanes will penetrate far beyond the zone of operations of land forces.

The bombing airplane may be considered the opening weapon of offensive tactics; its mobility and striking power at long ranges make it such. It can reach far beyond the frontiers and invade deeper into hostile territory in a few short hours than can any other branch of an army. With high explosive, gas, and incendiary or bacteria-carrying bombs it can bring the effects of war to any portion of the theater of war into which it has penetrated.

Control of the air must be maintained by the defense if the subsequent handicaps caused by its loss are to be prevented. Successful offensive bombing operations and establishment of contiguous aircraft bases must be denied to the enemy. To maintain control, it is necessary to have equipment which is capable of fighting the heavily armed bomber at long ranges and for sustained periods.

THE fighting airplane will be the main defensive weapon in the air, its mission being to engage the bomber. In order to compete with present bombers, the defending airplanes must possess superior armament, speed, and perhaps climb and maneuverability. Other factors such as superiority of numbers, trained personnel and coöperative ground batteries are necessary for adequate air defense, but striking power in the air is defined by high speed and efficient gunfire. In maneuvers of air defense, although fighter may be opposed to fighter, combats are much more probable between bomber and fighter. Escorts for a bomber squadron on long missions are improbable due to the insufficient fuel load carried by the 2-place pursuit and the fact that single-place pursuit airplanes can give little assistance to bombers. Since the pursuit ship cannot defend its rear, it must abandon support of the bombardment formation and turn and fight when attacked by hostile airplanes. However the modern bomber is well armed, and a defensive formation is well suited to repel a pursuit attack by its concentration and volume of fire and therefore would have little need of an escort.

As the speed of the bombing airplane approaches that of the pursuit airplane the difficulty of interception by the latter is aggravated and the time during which the fighter may attack after interception is diminished. The modern high-performance bomber is vastly superior to types used in the Great War. All-metal construction makes it more difficult to destroy; its increased speed and range give it tremendous striking power, and the use of the automatic pilot and improved blind-flying equipment allows the bomber to carry out its mission under weather conditions considered impossible during 1917-1918.

The pursuit or fighter pilot attacking a modern bomber has to cope with higher speeds and altitude, more efficient airplanes and formations, heavier armament, and a multiplicity of gun angles when avoiding the fire of bomber gunners. He has to shoot down airplanes which have structures that can be pierced with machine gun bullets without perceptible weakening. He must be able to intercept them at night, in fog, and in adverse weather. It is questionable whether the type of pursuit in general use today can hope to drive off or intercept the modern bomber—for once an air attack is started it rarely can be checked.

If the defense fighter can intercept the bomber before it has reached its objective or can impede the progress of the bomber by diverting it or forcing it to fight, the bomber would be at a disadvantage. The defense then has a chance to bring up reënforcing airplanes and ground batteries. However, unless the defense fighter has been warned previously of the raid and has had time to gain sufficient altitude to dive and overhaul the bomber, it will be impossible to prevent the raid. This leaves the fighter the alternative of attacking the bomber after it has accomplished its attack—since closing in during bombing operations would be hazardous and a serious hindrance to antiaircraft ground operations. Whether the bomber is destroyed before or after its attack, its loss still can be classed as a casualty. If a sufficient number are destroyed in each raid, the bomber squadron shortly would be wiped out. Persistent losses are detrimental to the morale and daring of personnel.

THE defense airplanes used against bombers may be classified as the pursuit or single-place interceptor, the 2- or 3-place fighter, and the multiplace (five or more) combat plane. Up to the present, the pursuit, or fighter, has been a single or 2-place airplane designed primarily for high speed and fast climb. It usually is equipped with from two to four machine guns ranging from caliber .30 to .50. In the single-place pursuit, these guns are mounted rigidly, and it is necessary to aim the ship in order to aim the guns. This type of airplane has been gradually developed from the fighter used during the closing years of the World War. Of late, some reversion to the 2-place fighter has taken place, an independent gunner being stationed in the rear

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Official Photograph, U. S. Army Air Corps

THE BOEING XB-15 "SUPER FLYING FORTRESS"—NEW EXPERIMENTAL ARMY BOMBER

cockpit. However, in the author's opinion, these two types are not capable of sustained fighting under present conditions and do not have the necessary qualities of a good combat airplane.

The pursuit airplane of today has been designed around the dog-fighting tactics of twenty years ago. Then, fighters were detailed for reconnaissance, photography, artillery cooperation, or some other need of the ground forces. Dog fighting practically was forced upon the belligerents due to inadequate performance of the airplanes and the methods of air warfare. It is highly improbable that such conditions would exist today, for the relative position of the fighter in army maneuvers of the present time is not the same—a fact which is especially true of the United States.

Tremendous improvements in airplanes, flying equipment, and aërial tactics preclude the use of one airplane in different capacities. When an airplane is constructed to perform many duties, it loses the characteristics of a distinct type. Airplanes now are designed and detailed in military maneuvers for specific duties which preclude their efficient use for other purposes.

The type of aircraft required for fighting and defense would not be the small single-seater or the slightly larger 2-seater, but a mighty, high-speed, heavily armed ship. Breguet has pointed out that all military aircraft should tend to become more and more alike in shape, differing only in dimensions. He postulates that the high-performance bomber possesses the qualities of a good fighter after it drops its bomb load. This theory gives rise to the assumption that the airplane to stop the bomber should be a similar craft with greater speed and more efficient armament—and considerably larger than present fighters.

The tactics of this type of airplane would not be the dog fight but more nearly those followed by modern naval cruisers. The single-seat pursuit airplanes which make up the fighter squadrons of most air forces today, offer little defense against a formation of modern "flying fortresses" such as the Boeing YB-17 or the fast Martin B-10-B and Douglas B-18. Indeed, the statement of Maj. Gen. M. M. Patrick that "the modern bomber is the most deadly and most effective weapon of modern warfare" does not exaggerate the facts. Sending a squadron of small pursuit ships to intercept a well-armed formation of bombers would seem a poor execution of military tactics and an inefficient use of war materials. Perhaps the correct method of employing the single-place airplane would be putting the "finishing touches" to a bomber after the combat airplane virtually has put it out of action.

In modern fighting aircraft, a high top speed is just as valuable to the attacking airplane as it is to the defending one. Light and heavy bombers now have speeds that are on a par with most pursuit ships—speeds of 250 miles an

hour or more being quite common. The value of speed to the bomber in preventing interception has been shown previously—a high speed enhancing the chances of slipping by the defensive airplanes and antiaircraft guns. Therefore the combat airplane must be designed primarily for high speed that it may have a better chance of intercepting and staging combat with the bomber at some distance from the latter's objective.

THE designer has at his disposal several means of increasing the speed of the airplane. A series of extensive tests has shown that with a good design, increases of from five to ten miles an hour are obtainable by careful and considerate construction and design of the component parts of the plane. Tests on fuselage and wing combinations run at the laboratories of the National Advisory Committee for Aëronautics indicate that one of the most favorable wing locations is that in which the wing is placed forward and slightly above the center or mid-wing position. From a military standpoint, this position offers wide fields of fire for both upper and lower guns. The effect of high aspect ratio, although increasing weight, is extremely advantageous to the military airplane since it produces a substantial increase in rate of climb and ceiling height while the top speed is increased by approximately two or three per cent.

Increased wing loadings through use of high-lift devices such as split or Fowler flaps, small wing areas, and controlled air flow about the wing, offer better means of increasing the top speed. By increasing the wing loading from 20 pounds per square foot to 30 pounds per square foot, an increase of approximately 4½ per cent in top speed is obtained. Higher wing loadings are more economical since they permit the full strength of the materials to be utilized and do away with minimum sizes. Thus, by tapering the wings, high aspect ratios and high wing loadings, a gain of approximately seven per cent in top speed is realized with a loss of only five or six per cent in climb and ceiling.

The necessity of high speed indicates the use of motors of high horsepower and low power loading, since these factors have a marked effect on take-off, climb, and speed at altitude—all of which are of utmost importance to the military airplane. In the United States, the air-cooled radial engine has predominated and development of the in-line liquid-cooled engine has all but ceased. There is little doubt that for equal horsepower the in-line engine has less drag than the radial. Moore and Rockefeller have shown in tests run at California Institute of Technology that there is a 21 per cent increase in speed with an 18 per cent decrease in power if an in-line engine of 1000 horsepower is used instead of a 55-inch diameter single-row radial engine developing 1250 brake horsepower.

WOOD has shown also that as the diameter of the radial engine increases, more of the horsepower is used in overcoming the resistance of the engine itself, until a point is reached at which *no matter how many engines are added, no increase of speed is obtainable.* Smooth and full-powered performance at high altitude, although possible with the radial air-cooled engine, is difficult to obtain. Efficient and even cooling of the radial engine at high altitude has become more and more difficult with higher horsepowers and may necessitate richer mixture ratios with the same power output as is obtained at sea level, thus reducing the fuel economy.

Comparing the air-cooled radial engine with the liquid-cooled in-line, the following is brought out: there is no reason to believe that the horsepower limit has been reached with the liquid-cooled engine; in fact, tests seem to indicate more efficient performance with the liquid-cooled engine than with the radial in the higher-powered engines. The liquid-cooled engine equipped with the turbo-type supercharger can hold sea-level power, without loss up to an altitude of 40,000 feet, while the radial engine with centrifugal-type supercharger suffers a fifteen per cent loss at the same altitude. Mechanically, the exhaust-gas turbo-blower is far superior to the gear-driven type. When starting at slow speeds, the former does not produce any appreciable pressure and therefore is not a load upon the engine. It also permits the free passage of the exhaust gases.

Official Photograph, U. S. Army Air Corps

PUSHER PROPELLERS AND AUTOMATIC CANNON MARK THE BELL XMF-1—NEW MULTIPLACE ARMY FIGHTER

In comparison, the centrifugal type is always a load upon the engine as the power required to turn it is practically constant, even if the air is not being compressed.

Further study of the two types of engines shows that more economical performance through use of higher compression ratios may be more readily achieved with the liquid-cooled engine than with the air-cooled engine, since it is accompanied by higher specific heats. With leaner fuel mixture and lower full throttle specific fuel consumption, the liquid-cooled engine should prove of great tactical value to the military airplane in maintaining an air patrol and in providing long range.

Official Photograph, U. S. Army Air Corps

THE CONSOLIDATED PB 2A—BIPLACE ARMY PURSUIT AIRPLANE

NO discussion of engine types for use in the fast combat airplane would be complete without including the prospects of the Diesel type. Here too, as with the liquid-cooled, in-line engine, we have a field that has been as yet undeveloped. Although the weight of the Diesel has been a prominent point in its disfavor, the saving in fuel consumption may offset the difference. Furthermore, as brake mean effective pressure increases and more rugged construction is necessary, the weights of the Diesel and gasoline engines will tend to become more nearly equal. The Diesel engine in climbing from sea level to 10,000 feet will increase its revolutions, thus increasing its power output; hence its power curve does not drop off as rapidly with altitude as does that of the gasoline engine, due to its higher compression ratio. Under normal combustion conditions in the Diesel cylinder, an oversupply of air and oxygen usually is sustained in ratio to the amount of fuel used, and the revolutions per minute decrease less rapidly than in a gasoline engine at altitudes above 10,000 feet.

The performance of a 2-stroke, scavenging, supercharged Diesel engine, besides giving smoother operation and more power strokes per revolution, has a remarkably economical fuel consumption. Considering the added military weight that can be carried due to a reduction of the amount of fuel necessary, the Diesel's economical consumption is an important advantage. Besides the advantages of fuel consumption, power, and revolutions per minute, the Diesel does not interfere with radio apparatus and reduces fire hazard—an especially favorable feature for the military airplane which may be attacked with incendiary bullets. It offers little chance of interference with the ignition system by means of rays, radio, or other such possibilities of future wars.

It is highly improbable that sufficient horsepower can be obtained from one motor. This fact, together with the added feature of safety in numbers, excludes the use of a single engine. An approximation of the weight of this type of airplane would be between 16,000 and 20,000 pounds which would necessitate two motors of 1100 to 1500 horsepower each. For best performance, such motors should have opposite rotation to counteract the high torque. Although the practice of using oppositely rotating motors has not been adopted in this country, it has been favored abroad. In France, motors of opposite rotation are compulsory for bimotored military ships.

THE installation of engine and propeller in front of the wing or fuselage seems to fit in well with present airplanes and engines. However, no exclusive reason for placing it there exists, and it is highly probable that this situation prevails only because the airplane has been developed to fit the power plant—the air-cooled engine has to be placed in front to obtain proper cooling. It is, however, against the principles of good design that the flight of the airplane should be impeded by blowing an accelerated stream of air back over the component parts, thus creating a high local drag. With the in-line, liquid-cooled engine, or opposed, narrow Diesel, it no longer should be necessary to place the propeller in front of the wing. With the propeller aft, there can be no loss of useful thrust and an increase in maximum propulsive efficiency may be possible. The efficiency depends upon V/nd, slipstream obstruction, and tip speed of the propeller. At maximum horizontal speeds both the thrusts and efficiency are increased by about three and six per cent, respectively, due to the presence of a body either in front or aft of the propeller, while the rotational speed is decreased by about three per cent, due to a slowing down of the approaching air.

It is therefore probable that the presence of the wing in front of the propeller should help to increase its efficiency without an increased drag. Tests conducted at the N.A.C.A. Laboratories indicate that a pusher propeller, driven by an engine inclosed in the wing, has a higher propulsive efficiency than a tractor propeller driven in the same manner.

Official Photograph, U. S. Army Air Corps

THE CURTISS P-36—SINGLE-SEATER ARMY PURSUIT AIRPLANE

In concluding, it should be pointed out that although the location of the engine, propeller, nacelles, and type of cowling has little effect on *climbing* speeds, these factors are important in attaining *high* speeds.

A REVIEW of present types of guns used on pursuit and fighter airplanes and their emplacement reveals how inadequately the planes are equipped as defensive or offensive weapons. The successful execution of a defensive or offensive engagement is dependent upon the heavy guns that can be trained upon the enemy throughout the entire period of action. The high speed of present airplanes places special significance upon long range and destructive effect of the gun. It is quite evident that size, placement, and mobility are the important factors and not the total number of guns.

The machine guns as used at present can do little damage to bombers and cannot be expected to force the fight. The adoption of the shell-firing cannon and explosive shell seems indicated. In order to make their fighting aircraft more effective, European and South American nations have been arming with rapid-fire cannon which fire 20-, 23-, 25- and 37-mm. explosive shells. The guns have higher muzzle velocities, flatter trajectories, and longer ranges than the caliber .30 and .50 machine guns. The explosive shell does away with the need for accurate sighting and timing since a direct hit is not necessary to cause damage. Large cannon can be placed in bimotored, multiplace combat airplanes without seriously affecting the performance of the planes. These guns can be mounted to produce a high concentration of fire in all sectors.

The most efficient disposition of the armament indicates the placement of the heavy guns in turrets in the extreme nose and upon the upper deck just forward of the tail surfaces, with secondary armament in the tail and bottom, and the smaller guns in blisters or turrets along the sides. Such arrangement gives the widest train of fire to the heaviest guns and the greatest possible subdivision of the secondary armament about the airplane. It thus assures overlapping angles of fire and gives the airplane commander complete use of a majority if not all of his weapons in any combat situation. The heavy nose gun can cover the forward hemisphere to within ten or fifteen degrees of a vertical plane through the forward end of the airplane. The upper rear turret covers the entire upper hemisphere and possibly slightly below the horizontal on either side. The secondary batteries, in the tail, bottom, and sides, provide adequate defensive and offensive fire in those sectors. The arrangement of the heaviest guns fore and aft allows the preponderance in armament to be effective. In a running duel it is evident that the combat airplane with a nose or upper-deck gun of long range can hold its opponent in its line of fire, at the same time offering the smallest target.

In a retreating action, the course of the pursued airplane determines the path of the pursuer, and it has been shown that the latter can do little damage if he lacks range and fire ahead and is unable to close in upon his opponent.

Guns placed in *independently* movable turrets; *i.e.*, turrets which can be rotated in all directions without being affected by the maneuvers of the plane, offer the best means of keeping fire trained on the targets at all times. Clear vision and large window areas must be adjacent to all gun positions in order to allow the gunner ample time to sight and train his guns.

As a complement to the batteries, combat airplanes should be equipped with small aërial grenades in order to carry out bombing operations against bombers. Such bombs could be carried in the fuselage or in the wings, with a bombing-operations station situated just aft of the pilots' cockpit.

Maneuverability is essential to the fighter only when the airplane is dependent upon rapid climbing and curvilinear flight for its defensive or offensive operations against enemy aircraft. The maneuverable airplane also may

be said to be an offspring of dog-fight tactics. The high-speed combat airplane carrying heavy armament has little need of exceptional maneuverability. Besides, the speeds now attained prohibit sudden, sharp, or violent maneuvers. The physiological effects of maneuvers at high speed are well known—"blacking out," nasal hemorrhage and straining of the internal organs have been experienced by many pilots. In high-speed sharp turns, pull-outs, and spins, the pilot very often loses muscular control—is quite incapable of moving his arms, legs, or body. M. Richou states that a pilot weighing 70 kilograms (154 pounds) flying at 500 kilometers (311 miles) an hour and turning on a radius of 200 meters (655 feet), will exert a pressure of approximately 800 kilograms (1765 pounds) on his seat. Since a pilot or gunner does not have full muscular control under such conditions of flight, he should not be expected to maneuver his airplane or guns very efficiently. Although an endeavor has been made in several European countries to train a school of high-speed pilots, in time of war it would be difficult to maintain such an arm at full strength from raw recruits—a serious drawback to its usefulness.

ALTHOUGH we may exclude exceptionable maneuverability from the combat airplane, its strategic value would be enhanced by rapid climb and high ceiling. These features permit the combat airplane to rise above enemy craft and change formations rapidly; this is favorable to quick interception. A rapid climb allows the airplane to get into the air quickly and to reach the altitude of incoming bombers in a minimum time. Where "salvo bombing" is used, a high rate of climb will permit the combat plane to rise quickly to a bombing position after interception. Thus the element of surprise, which always has been considered an important feature, is introduced into the maneuver. Fast striking power such as this is highly advantageous. The importance and effect of high aspect ratio and good wing design in securing a high rate of climb and ceiling cannot be overlooked.

Efficiently designed control surfaces are responsible in a large measure for securing good maneuverability and stability. A somewhat recent improvement is the twin-rudder arrangement. The benefits derived from twin rudders are two fold: they are better aërodynamically and they permit a better installation of the tail gun. When twin vertical surfaces are placed at the ends or adjacent to the ends of the horizontal surface, they have the effect of end plates and increase the effective aspect ratio of the surface. Horizontal surfaces built with a large span and short chord to obtain a high aspect ratio are costly due to heavy structure; besides, large unsupported surfaces are subject to flutter. Therefore, since the effect of the twin vertical surfaces is to increase the effective aspect ratio, thus cutting down the actual span, they may be considered as very desirable. Furthermore, an increase in the effective aspect ratio of the horizontal tail surfaces reduces the relative horizontal tail area required, thus saving weight.

From a military standpoint, the twin surfaces permit a better gun emplacement in the tail and reduce the hazard of the airplane being shot down out of control. Should one rudder be damaged, the pilot still can maintain control of the airplane with the other.

Flight at altitudes above 20,000 feet, however costly, is indispensable to the combat plane. The bomber, as previously stated, will fly at high altitudes for protective cover and speed. Flight in the substratosphere necessitates supercharged cabins and a means of conditioning the air both chemically and physically. Separation of the fuselage into sealed compartments offers a most logical method of keeping the fuselage air-tight under fighting conditions. Thus, although such separation hinders the quick interchange and passage of personnel, it allows one compartment to be punctured without disturbing effects on the others. A centrally located oxygen supply then can be maintained, supplying all compartments through branch ducts. When a compartment is riddled and punctured by gunfire, automatic valves in the duct lines at that compartment can be adjusted to increase the oxygen supply or maintain the correct CO_2 content. As an auxiliary supply, a distributing oxygen manifold to which oxygen masks readily may be attached should run throughout the length of the ship. Such apparatus makes the immediate repair of large punctures unnecessary and will not remove personnel from their stations. With pressure compartments, suitable apparatus for keeping the air at comfortable temperatures and humidity is necessary, and a circulation of air must be maintained.

AN absolutely essential, but most rarely mentioned, part of any airplane is its personnel. For the combat airplane of this type a 7-man crew is justified. Here again, the advantage of this type of airplane over the single-place or dual-place fighter is exemplified. In the single-place pursuit and dual-place fighters there is not sufficient personnel to carry on a sustained combat. In the pursuits, the pilot has to maneuver his plane and tend to his guns at the same time; he has a very limited field of fire. Assuming the pilot of the single-seater to be seriously or fatally wounded, the airplane is either effectively out of combat or a menace to both sides. While 2-place fighters may offer some advantages, they very often are equipped with but a single control. If a dual control is incorporated, with one occupant injured, the ship is not as effective as before. With the multiplace combat airplane, however, casualties to the personnel do not decrease its effectiveness materially.

As a final argument in favor of the multiplace combat airplane, its use as a patrol ship compared to a patrol of dual-place fighters has many superior features. A patrol of combat airplanes acting in coöperation with ground observation stations and sound equipment is more likely to intercept raiding bombers, since the combat craft can cruise about at throttled power for many hours and still have sufficient fuel in reserve to carry on a combat. In connection with patrol work, refueling while in flight will materially increase the cruising range. The automatic pilot will help to relieve the strain on the pilot.

To sum up, the superiority of the multiplace combat ship over the single-place pursuit or dual-place fighter as a first-class fighting machine is evident for the following reasons: 1. It is capable of sustained fighting at all times and under varied conditions. 2. It is heavily armed and can carry large-bore weapons without serious effect upon structure or performance. 3. It has a heavy concentration of fire. 4. It is capable of fighting at high altitudes without undue strain or great discomfort to its personnel. 5. It has adequate personnel and can be effective even when casualties occur.

The Navy Inspection System

Assurance of Quality in Engineering Materials

By Capt. Ralph J. Hanson, U.S.N.*

THE Navy inspection system came into being nearly one hundred and fifty years ago when the attacks by French cruisers on our commerce prompted Congress, in 1794, to authorize the construction of six frigates, two of which still survive, although reconstructed, in the CONSTITUTION and the CONSTELLATION. Naval officers were assigned to the ships in the early stages of their construction ultimately to man them when completed and commissioned, but initially to inspect both workmanship and materials, including the assembly of equipage, ordnance, naval stores and accessories.

This system has been carried down to the present day, although with numerous developments and amplifications to suit advances in complexity of design and materials involved in the transition from wooden ships, through iron and medium steel, to the ships of today, embodying the latest developments of the metallurgical and mechanical sciences.

At this point I will digress for a moment to picture briefly the historical background of our Navy which has had so intimate and, may I say, so important a connection with material development and procurement in this country. Just as our national economic history has been characterized by recurrent cycles of prosperity and depression, so our naval history has been characterized by similar periods of inflation and deflation, with corresponding reactions both upon our international relations and upon the economic and industrial life of the country as the Navy procurement problems spread in ever-widening circles from the seaboard to the great manufacturing centers of the interior.

The United States Navy began, then, with the laying down of the keel of the CONSTITUTION in 1794 on the foundations of a fine naval tradition begun by John Paul Jones and his associates of the Continental marine. After the quasi-war with France in 1798, a series of brilliant exploits during the years 1803 to 1805 against the pirates of the Barbary Coast, and our successes in the War of 1812, there followed a period of retrogression, punctuated notably by a brief period of expansion during the Mexican War and the opening up of Japan by Com. Matthew Calbraith Perry in 1854.

This period of stagnation was terminated abruptly by a tremendous expansion of our sea forces for blockading purposes, including control of the Mississippi River, during the War Between the States. After Appomattox, however, the Navy again was allowed to slump until it reached an almost unprecedented low during the 1870's. It was during this period that our merchant fleet of clipper ships, likewise having reached its peak of distinction, also began to decline owing to the advent of steam propulsion, iron hulls, and the opening of the Suez Canal—three factors fostered by Great Britain, incidentally, and operating greatly to her advantage. Meanwhile, in 1842, the Board of Navy Commissioners established for administration of the Navy in 1815, had been superseded by a group of civilian bureaus for *technical* naval supply and maintenance. Nothing approaching a general naval staff for control of fleet operations was to come for some seventy years thereafter.

IN the middle 1880's, popular sentiment led to the creation of the so-called "White Squadron" of four small light cruisers constituting the beginnings of a new *steel* navy. There followed, fortunately for us, a continued upbuilding of the Navy throughout the early 1890's, so that we were in a position strong enough in 1898 to destroy the relatively weak and inefficient navy of Spain after the sinking of the MAINE in Havana harbor.

Profiting by the lessons of this rather "small-time" war, and stimulated by our not-too-creditable successes against a weak adversary, the upbuilding of the Navy was continued at accelerated pace under the able administration of President Theodore Roosevelt who, like our President today, previously had served as Assistant Secretary of the Navy, and was therefore both interested in and well informed of its shortcomings and its needs. It was during his administration in the years 1907-1909 that occasion was taken to show our naval power in a globe-girdling cruise of the so-called "battle fleet," in which I had the pleasure to participate as a midshipman in one of our newest battleships—and very fine ones they were, too, for the period.

The pendulum had begun to swing back somewhat in subsequent years until the outbreak of the World War led to a feverish and extravagant resumption of building a Navy which President Wilson in 1916 decreed should be "second to none." This noteworthy policy was indeed on a fair way to accomplishment, definitely to the displeasure of several foreign naval powers, when the sentiment of a country and a world weary with war led us into the Washington Limitation Conference of 1921-1922 and subsequently to the London Limitation Conference of 1930, which I had the privilege of attending as a technical advisor to our Ambassador, an ex-officio member of the American delegation. Idealistically leading the way to the limitation of armaments by *example*, we contracted under the Washington Treaty to scrap not only numerous prewar battleships but many fine new battleships and battle cruisers of postwar design—all of them laid down and some in an advanced stage of construction—a sacrifice far and away beyond anything contributed by any of the other signatory powers.

For the next six or seven years we laid down practically nothing but ten light cruisers of the RICHMOND class (excellent for their size and type) which had been excluded from the provisions of the Washington Treaty, applying only to capital ships. Similarly, in 1930 when foreign navies consistently had been built up in all types not restricted by the Washington Treaty and while our own Navy had been allowed to languish and become relegated to a position of secondary power, except for battleships, we agreed to limitation of types which had not been included in the Washing-

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ton agreement; *viz.*, aircraft carriers, cruisers, destroyers, and submarines. Like prohibition, it was a "noble experiment," and like prohibition, it neither prohibited nor did it last.

It dawned upon the country during this period that while we were lagging far behind in ship construction and in our treaty quotas, other signatories to the limitation treaties were continuing to build up to the limits permitted them. Commencing in 1924, Congress authorized the construction of a series of eighteen heavy cruisers, followed in 1929 by a program of nine light cruisers—both of which types are at least the equals of corresponding types abroad. Concurrently, a program of destroyers and submarines was authorized to replace the obsolescent vessels of those types built during and before the World War. The result is that we now have in commission or under construction a fleet of nearly one hundred and fifty vessels of postwar design and construction, half of which are already in commission and the other half scheduled for completion at intervals during the next four years. Of course there has been no limitation on construction, by international treaty, since December 31, 1936.

The total value of material accepted by the Field Inspection Service of the Navy during each of the past three years has closely approximated one hundred and twenty-five million dollars, representing a tonnage of over half a million each year, of which some twenty-five per cent by value and about twenty per cent by tonnage has been inspected and accepted in the Pittsburgh Inspection District. Recently the value of such material in that district alone has been running at about three and a quarter million dollars a month.

SINCE the establishment of the present bureau system of administration by Congress in 1842, the responsibility for funds appropriated for the building and maintenance of the Navy is lodged by statute with various technical, so-called material bureaus of the Navy Department, including the Bureau of Construction and Repair, the Bureau of Engineering, the Bureau of Ordnance and the Bureau of Aëronautics. Each of these is responsible for the determination of the characteristics and quantities of materials required under its cognizance, including the designs and specifications under which those materials are purchased. Requisitions for such purchase are initiated by the respective bureaus having cognizance.

The procurement of these materials with certain notable exceptions, including new vessels, public works, armament, ammunition and gun forgings, is lodged with the purchasing bureau of the Navy Department—the Bureau of Supplies and Accounts—which also has initial cognizance of certain items of material, such as food supplies, clothing for enlisted men, and fuel for the fleet and for shore stations. The Bureau of Supplies and Accounts advertises for bids and awards contracts for all material, except as noted, and after the articles have been inspected and delivered, pays for them and handles or stores them until drawn for service. The Bureau of Yards and Docks awards contracts for public works in general, and the Judge Advocate General of the Navy awards contracts for new ships to be built by private builders, and also for lands.

Until 1927 the Navy Regulations required that each material bureau inspect all materials for its own use, but for the past eleven years the interests of the bureaus as regards inspection have been pooled, so that material for all bureaus in any one inspection district—with certain noteworthy exceptions referred to hereafter—is inspected under the Inspector of Naval Material for that district regardless of whether he belongs to the line or the Construction Corps of the Navy, following the general trend of consolidation of activities in the interests of economy.

Material procurement for the Navy falls into three principal categories: (1) The construction of ships by private shipyards, including hulls, propelling machinery, certain auxiliary machinery and installation of armor and armament.

(2) Materials inspected at the source or place of manufacture, including items of material or equipment either for use in ships under construction—both those building in Navy yards and those building in private shipyards—for use in ships already in service, for the routine maintenance and operation of the fleet, or for stock or use at shore stations. Frequently this group includes main propelling machinery and important auxiliaries referred to in the first group when, as in the case of submarines and sometimes for vessels of other types, this machinery is manufactured elsewhere than at the plant of the shipbuilder.

(3) A considerable quantity of miscellaneous materials, many of which are more or less definitely standardized. Some of these are even of commercial quality and may or may not require inspection at the source, but *must* undergo inspection of one sort or another before acceptance and use by the Navy, whether at a shore station or in the fleet. Included in this group are gasoline, fuel and lubricating oils—prospective bidders' samples of which are tested annually at the Engineering Experiment Station at Annapolis prior to opening of bids and award of annual contract. Also in this category are clothing and small stores, provisions—including fresh meats and vegetables—medical supplies, surgical instruments, musical instruments, incandescent lamps, vacuum tubes, etc.

Many items in this group, some five hundred at present, are covered by the Navy Department's "Acceptable List of Approved Materials," both the composition and merits of which have been demonstrated by tests at a naval laboratory and thereafter require inspection only for quantity and periodic comparison with standard samples as long as they continue to give satisfactory performance in service. If subsequent failure on comparative check test indicates deterioration in the quality of the product, the item is removed from the approved list. The manufacturers naturally are very anxious to avoid such a contingency and make every effort to maintain the high standard of their product on which inclusion in the acceptable list originally was based.

Notable exceptions to procurement by the Bureau of Supplies and Accounts, as stated above, are certain items of ordnance—including gun forgings, armor, and ammunition—for the procurement of which the Bureau of Ordnance is directly responsible. Other exceptions are public works for shore stations, including buildings, dry docks, fixed and traveling cranes, and railway equipment for the procurement as well as the design of which the Bureau of Yards and Docks is directly responsible; also lands and new vessels, contracts for which are let by the Judge Advocate General.

In the main, the three categories or groups of materials described above as governing *procurement*, likewise indicate and govern the *inspection procedure* accorded them.

For inspections in the first category named above, that is,

inspection of ships under construction at the seven commercial shipyards now holding contracts with the Navy Department, the Government maintains offices of a superintending constructor, an inspector of machinery, and an inspector of ordnance. These also usually inspect navigational material. In addition, where ships were constructed on a "cost-plus" basis as during the war, a naval cost inspector was detailed to each yard to check and audit the company's accounts. Under the terms of the Vinson Bill by which shipbuilders are limited to a ten per cent profit, this function has been revived with reference to private shipyards, the cost inspector reporting to the Compensation Board in the Navy Department. Inspectors of machinery and inspectors of ordnance likewise are maintained at certain outlying plants manufacturing major units of machinery and armament or armor.

THE inspector of machinery, the superintending constructor and the inspector of ordnance are the representatives in the building yard of their respective technical bureaus of the Navy Department; namely, the bureaus of Engineering, Construction and Repair, and Ordnance. Each is responsible directly to his own bureau and serves as the intermediary between that bureau and the contractor on all matters affecting compliance with design, specifications, workmanship, etc.

The first two, the inspector of machinery and the superintending constructor, having by far the greater volume of inspection work, have staffs of assistants, the size of which depends on the amount and magnitude of construction in progress at the shipyard. However, the staffs usually comprise at least one or two commissioned assistants (officers of the engineering and construction branches) a considerable force of draftsmen (up to a score or more), and a force of civilian special mechanics numbering anywhere from four to a dozen.

All detailed plans prepared by the contractor require careful check—for compliance with the Department's contract plans and specifications—and also the inspector's approval stamp, or in some cases, reference by him to his bureau for final approval before being issued to the shipbuilder's shops. The inspector's drafting force likewise scrutinizes and in some cases initiates, rather elaborate test memoranda to cover shop and installation tests on practically every piece of machinery, and all piping and electrical installations, interior fittings, etc., which enter into the construction of the ship.

The staff of civilian special mechanics, usually under the supervision of an officer assistant, follows continuously the fabrication or manufacture and the installation of practically every part and system entering into the ship, including main, secondary and antiaircraft batteries and their fire-control systems. This staff also witnesses installation and completion tests, including tightness tests of compartments, main and auxiliary machinery tests, etc.

It is thus seen that work prosecuted under each technical bureau is continuously checked and inspected by the staff of naval inspectors in the builder's plant from the time the contract for the ship is awarded and the contract plans and specifications received by the contractor, until the vessel is delivered to the Government upon satisfactory completion and commissioning—and in a measure even until the expiration of the guarantee period for satisfactory operation—usually one year after delivery.

Reimbursement to the contractor usually is divided into some forty or fifty equal payments based on the degree of completion of the vessel and requires certification by the appropriate inspector that work has been satisfactorily completed up to this stage and that the payment stipulated by the contract has been earned.

Usually also at least one ship of a class is completely weighed (by weighing component items of material) as construction proceeds. This weighing is a function of the superintending constructor's office.

FOR ships built in Navy yards, the inspection procedure is somewhat less formal and less highly systematized than in private shipyards, for unlike private shipyards and, I believe, most if not all arsenals, there is no separate and completely independent staff of inspectors, either officer or civilian, *except*—and this is a very important exception—those officers, warrant officers, chief petty officers and enlisted ratings who are assigned to the vessels under construction long in advance of their completion and while installation tests and trials are being conducted. The Navy regulations place upon these officers a definite responsibility for inspection of workmanship and satisfactory compliance with plans and specifications.

The coöperation between this ship's inspection force and the yard personnel in charge of construction is necessarily very close. Furthermore, most of the officers assigned to supervision of construction have had previous experience afloat, as well as in ship construction, and many of them know that they later will become responsible heads of departments or possibly even commanding officers of these same ships. Therefore a certain measure of self-interest, as well as interest in the good of the service, prompts them to take every possible means within their power to see that only the best materials and workmanship go into the vessels building under their supervision. From my own personal experience, I feel I may say that in the inspection and the results accomplished, the ships built in Navy yards are treated just as conscientiously and just as honestly as the contract-built ships, and they are, of course, subjected to the same test of service.

Upon completion of new vessels, whether built under private contract or at a Navy yard, and before their entry into service, these ships are subjected to very rigid full-power trials, tests and thorough over-all inspection by a permanently constituted Board of Inspection and Survey for Ships, of which one section, for the East Coast, bases on Washington, D. C., and one for the West Coast, on Long Beach, Calif. These final inspection boards, if we may so describe them, are comprised of ten or twelve highly qualified and skilled technical officers with a rear admiral or senior captain of the line of the Navy as senior member—each member being a specialist in his line, whether engineering, gunnery, naval construction or whatever it may be.

I can assure you that this board puts each new ship through her paces in a most thorough and exacting manner before she is permitted to join the fleet. As I shall point out later, naval inspection of ships does not stop even at this point. All vessels in service continue to receive thorough over-all inspections by the Board of Inspection and Survey throughout their commissioned life at intervals prescribed by regulations as not in excess of three years—this in addition to more frequent inspections by the forces afloat.

The third category of inspections covers material ordinarily of such standardized character as to require inspection chiefly

for quantity at the point of delivery, usually a Navy yard or fleet supply base. As previously stated, a great many materials in this category are procured from manufacturers who have demonstrated their capacity and integrity and good faith in supplying materials to standard specifications and have been placed by the Navy Department on the acceptable list of approved materials. Inspection of materials in this category usually is made only for quantity, workmanship and surface condition. If this inspection has been made at the source, a check inspection for quantity and satisfactory condition on receipt usually is made upon this as well as on other materials by the comparatively small civilian inspection forces at Navy yards and other depots where the materials are delivered. A guaranty or sworn affidavit is customarily obtained from the contractor stating that the material submitted for inspection is equal to the sample previously submitted to the naval laboratory for the original acceptance test on which inclusion in the acceptable list of approved materials was based. A representative sample then is selected and forwarded to a laboratory or depot at which standard samples are maintained, for comparison with approved samples.

THE comparison tests usually are conducted by the same naval laboratory which conducted the approval test. A check on material, such as lubricating oil and gasoline, delivered on blanket annual contracts is maintained by periodically conducting check tests on samples forwarded from designated naval activities. It occasionally has happened that material covered by a contract requiring inspection at the source has been reinspected for condition as well as quantity by the yard inspection force at point of delivery although not specifically provided for in the contract. This sometimes has raised embarrassing but not insurmountable differences of opinion between field and yard inspection forces, resulting in what really has proved to be a very healthy inquiry into the reasons for these differences of opinion.

Also in this category may be included certain special materials which are inspected for the Navy by other branches of the Government, and those inspected by employees of the Navy Department's Inspection Service after delivery. The former include fresh meats and vegetables inspected by employees of the Bureau of Animal Industry of the Department of Agriculture, and incandescent light globes inspected by the Bureau of Standards of the Department of Commerce. The latter include dried and tinned provisions, clothing, textiles, garments, mess gear, and musical instruments inspected chiefly by personnel under the Bureau of Supplies and Accounts, and medical supplies and surgical instruments inspected by the Bureau of Medicine and Surgery.

Timber, which still is required by the Navy, although in diminishing quantities, usually is inspected at the source (the mills) although the tendency is to extend the policy of purchase under the specifications and grading rules of the various national lumber associations and to accept it under their excellent inspection systems wherever available, subject usually to check inspection for quantity and condition at the point of delivery.

We now return to the second category of inspections. These inspections are covered in their entirety by the Field Inspection Service of the Navy Department and apply to a very large quantity of material (large in both tonnage and aggregate value) regardless of whether procured by the purchasing agents of shipbuilders for incorporation in vessels building under contract, or whether initially contracted for by the Bureau of Supplies and Accounts of the Navy Department, or, as in the case of certain special materials indicated above, by the technical material bureaus and offices having specific cognizance of procurement as well as design and determination of requirements.

VAST progress has been made in naval design during the past thirty or forty years and particularly since the World War. The metallurgical and engineering sciences have made possible the weight reduction imposed by the Washington and London Treaties and by securing maximum efficiency, fighting value, and radius of action within minimum displacement. Concurrently, manufacture of materials for naval construction has gone far afield from the seaboard to industrial centers like the Pittsburgh area—points often remote from building yards, fleet supply bases and naval shore stations. It is, of course, obviously wise and economical to inspect as much of this material as practicable at the point of manufacture—the source—and to reject any unsatisfactory material *there,* instead of after shipment (frequently over long distances) to the points where the materials are to be assembled and used.

For the purposes of the Field Inspection Service, the continental United States is divided into twelve inspection districts. These are based partly on geographical and partly on industrial lines centering about the most important industrial cities in their respective areas without particular regard to the boundaries of the fifteen so-called Naval Districts into which the United States and its outlying possessions are divided for purposes of naval (military) administration.

For example, my own *inspection* district extends into four different *naval* districts, but this causes no difficulties of administration such as might be supposed from casual observation. The Pittsburgh Inspection District is by far the largest of the twelve in tonnage and value of material inspected and accepted annually, handling, as stated before, about twenty-five per cent of the total by value, and about twenty per cent by tonnage. In geographical extent or area it is centrally located, owing to the fact that certain inspection districts in the Southeast, Southwest and Northwest cover very large geographical areas but contain relatively less numerous or less important industrial activities. The Pittsburgh District extends roughly from Detroit and northwestern Ohio on the west, to Rochester, N. Y. on the east; and from the Great Lakes south to western Maryland, the middle of West Virginia and the Virginia State line. It comprises a total area of nearly 100,000 square miles.

The cost of field inspection for all districts now averages from $1.90 to $2 per ton of material accepted, or in terms of cost per dollar of value of material, the cost of inspection ranges on the average, from 0.7 of a cent to 0.9 of a cent; that is, the *inspection* of each dollar's worth of material accepted, costs, on the average, less than one per cent of its value. Monthly summaries of inspection costs, both by tonnage and by dollar value, are compiled for each inspection district by the inspector of that district and collated in the Navy Department for all districts. A summary of costs by districts is disseminated to the various inspectors of naval material, so that they may see themselves on a comparative or competitive basis. It then becomes a natural point of pride with each inspector to cut his inspection costs down as low as practi-

cable, in comparison with costs in other districts, so far as this can be done without sacrifice in quality of inspection. And the inspector worth his salt is usually alert to find points in his inspection procedure in which further economies can be effected.

THE twelve inspection districts to which I have referred above are designated by the names of their principal industrial centers; as, the Boston, Hartford, Schenectady, New York, Bethlehem, Philadelphia, Pittsburgh, Cincinnati, Chicago, Atlanta, San Francisco and Seattle Inspection Districts. For purposes of administrative control, they are allocated, six to the Bureau of Engineering, five to the Bureau of Construction and Repair, and one to the Bureau of Ordnance—the division of assignments between the first two bureaus named being more or less arbitrary, inasmuch as since 1927 *all* material procured in a single district comes, with few exceptions, under the inspection of a single inspector of naval material regardless of the bureau under the specifications and plans of which the material is procured—whether Construction and Repair, Engineering, Ordnance, Yards and Docks, etc.

In other words, the inspector of naval material is the representative within his own inspection district of all bureaus of the Navy Department procuring material in that district, with the exception of naval aircraft and certain other materials which I have indicated. The Bureau of Aëronautics conducts the inspection of aircraft under construction due to the fact that this is a relatively new and very highly specialized industry. Its inspections are conducted through some thirteen offices of inspectors of naval aircraft—seven in the East, three in Ohio, one in Kansas, and two on the Pacific Coast. However, the various inspectors of naval material also are frequently called on to conduct inspections on materials entering into the construction and equipment of naval aircraft.

To keep pace with advances in engineering, naval science and industrial practice, the Navy Department has from time to time found it necessary to add laboratories for testing various types of material to the facilities of its Inspection Service. Such testing laboratories now are maintained in conjunction with the Naval Inspection Service and located at the Navy yards at New York, Philadelphia, Norfolk, and Mare Island; at the Engineering Experiment Station, Annapolis; the Naval Research Laboratory at Bellevue, D. C.; the Naval Powder Factory at Indianhead, Md.; and at the office of the inspector of naval material, Pittsburgh District.

The Naval Proving Ground at Dahlgren, Va., conducts gunfire tests on armor and projectiles. All these laboratories perform inspection tests on various types of materials and, in addition, carry on research and development in connection with the improvement of materials for naval use, in both design and composition, to the end that the naval service may keep abreast of the times and be assured of the most efficient and most effective materials for its purposes. The Navy Department also for purposes of inspection tests accepts analyses from accredited commercial laboratories.

Mention should be made, in passing, of five rather distinctive clauses peculiar to many naval contracts:

(1) The "liquidated damage clause" providing for the assessment of a penalty for delay in delivery of material beyond the contract date;

(2) A clause included in every contract or order over $10,000 in value requiring statement of compliance with the provisions of the Vinson Act which prohibits a profit in excess of ten per cent;

(3) A clause included in all contracts of $10,000 value or over, summarizing requirements of the Walsh-Healy Act prescribing hours, wages and working conditions;

(4) The tax-exemption clause which permits manufacturers to claim exemption from Federal excise and state taxes on materials used in the execution of a contract;

(5) A clause in contracts for secret or confidential material, stipulating a penalty of $10,000 fine or two years' imprisonment, or both, for willfully transmitting, or through gross negligence permitting to be transmitted to anyone not entitled to receive it, any confidential or secret information intrusted to the contractor. This is from the so-called Espionage Act, enacted by Congress on June 15, 1917 and resembling somewhat the British "Defense of the Realm Act."

NOW as to the *procedure* for inspection of materials in the second category. The most common form of Navy contract specifies some definite quantity of specific items of material. After the contractor and the Paymaster General have signed the contract, a copy is forwarded to the requiring activity and to the inspection district concerned. If the contractor sublets a portion of the work to other manufacturers, he sends copies of his purchase orders on those manufacturers to the naval inspector having cognizance of the work being performed under the contract. The inspector distributes these purchase orders to the inspection offices in whose districts the material ordered is to be manufactured. Either the contract or the purchase order is the inspector's authority to conduct inspection.

Inspection is conducted at the place of manufacture unless inspection after delivery is specifically required or unless the value of the material is so small as not to warrant the expense of conducting the inspection at the source. Inspection at source is obviously to the advantage of the manufacturer in point of conservation of transportation costs in case of rejection and to the advantage of contractor and the Government in saving time.

The actual physical inspection of the material is usually made by a civilian assistant inspector who proceeds to the manufacturer's plant armed with the necessary specifications, plans, and a copy of the contract or order. The surface inspection is made in accordance with the plans and specifications; physical tests generally are conducted at the contractor's plant, and samples for chemical analysis and other tests are taken and forwarded to a naval testing laboratory. The inspector then submits to the Inspection Office certain forms indicating what material has been inspected and the action taken thereon. The manufacturer also is furnished with information concerning the material accepted or rejected in order that he may prepare the necessary shipping forms for transmittal to the Inspection Office.

When material has been shipped and accepted by the receiving activity, the function of the Field Inspection Service is at an end. The receiving activity of course conducts its own inspection for quantity and condition on receipt. Occasionally on this inspection defects are brought to light which should have been found by the field inspector. Sometimes defects not visible on field inspection become apparent later; for example, cracks in specially treated steel plates brought out in the pickling process conducted by a shipbuilding

company or a Navy yard. The inspection force at a large Navy yard consists ordinarily of some six to ten civilian inspectors operating under the manager of the industrial department. The supply department conducts further inspection on its own account for quantity and condition when storing materials for future issue. Thus we see that, all in all, naval material has been very thoroughly inspected by the time it is ready for use.

SO far I have described the procedure for naval inspection of materials required for the construction, equipment, and operation of the Navy and its vessels. I would now like to refer briefly to the inspection methods employed to assure that ships in service are maintained at the proper standard of material efficiency. The very complete routine of inspections conducted by the forces afloat within the various commands has as its aim the establishment and maintenance of a high degree of efficiency of both personnel and material. These inspections do not come within the purview of the Naval Inspection Service as such, but they are a very necessary and important part of the Navy's inspection system.

Each naval vessel in service is subjected to a thorough detailed material inspection at least once every three years, the inspection being conducted by the Board of Inspection and Survey for Ships, referred to above as constituting a part of the Naval Inspection Service. For the purposes of inspection by the Board of Inspection and Survey, the vessel is assigned an overhaul period of about two weeks to permit her crew to open up at least fifty per cent of all machinery installed. Every unit opened is carefully examined by the board for proper working clearances, indications of wear, and desirability of overhaul, repair or alteration. A detailed report in regard to these features is made by the board to its immediate superior, the Chief of Naval Operations, with copies to the bureaus concerned, to the vessel's home yard, the forces afloat and the commanding officer. The inspection by the Board of Inspection and Survey is usually, although not invariably, purposely timed to precede a scheduled Navy-yard overhaul by about three to six months. In transmitting requests for Navy-yard work to be accomplished during the subsequent overhaul, the commanding officer must be guided, though not limited, by the board's recommendations as approved or modified by the appropriate bureaus of the Navy Department.

It readily is apparent that since the function of the Board of Inspection and Survey is to find and to recommend remedies for defects, the ship's attitude should be, and almost invariably is, one of helpful exposure of any difficulties with, or shortcomings of, material; there is no tendency to "cover up" defects in a spirit of fancied self-interest or self-protection.

I should like to refer briefly to one point which is almost a hobby with me in the administration of my inspection district. It concerns the relations between the Government inspection service and contractors. Among all my assistants, I insist upon a scrupulous regard and consideration not only for the contractural *rights* of the contractor, but for his *feelings* and probable reactions as a human being. The best business relations can be maintained only where there is a *mutual* feeling of respect and liking and mutual confidence as to good intent and good faith. I think that in the mechanism of government—government officialdom and red tape, if you like—some of us are prone to overlook or forget the human factor and to presume upon what we might call the Government's right of eminent domain. I impress upon my inspectors the necessity for avoiding an arbitrary attitude.

I also desire to pay a tribute here to what I believe in the main to be the very high caliber of our civilian inspection force—all of whom are obtained through examination and certification by the Civil Service Commission—as regards integrity, which must always come first, experience, ability, conscientious application to their work, devotion to the Government's interests, and adaptability. I believe that in the main they do an excellent job.

Among them we find all varieties of training and experience, including college-trained bachelors of science, electrical experts, mechanics, former railway inspectors, timber experts, etc. But regardless of training, a sound knowledge of psychology and of human nature is, after all, one of the prime requisites of a good inspector as it is of a good officer or a good man in any walk of life. Bad psychology and lack of tact in an inspector can do the Government almost as much harm in its procurement relations as ignorance or stupidity.

IN conclusion, it is desirable to consider briefly the adaptability of the Naval Inspection Service, as at present organized, for expansion to a war-time basis. Such an expansion, involving the recruitment of the required large number of additional civilian inspectors and their indoctrination in naval requirements and procedure, will not prove a simple matter, particularly in view of competing demands for inspectors in other Government departments and for experienced mechanics in Navy yards, private shipyards, and among munition manufacturers of all sorts.

However, many men are available throughout the country whose age or some physical disability renders unsuitable for enlistment in the armed forces, but whose experience and integrity make generally suitable for inspection work. It remains to determine the priority of claim for inspection over production. It also probably would be necessary, as was the case in the World War, to replace many of the officers now assigned to inspection duty with retired officers and those available and qualified for such duty among the officers of the Reserve.

In this connection, one great difference which exists between the procurement problem of the Army and that of the Navy, involving a radical difference in magnitude and scope, if not in character of peace-time inspection, is that the Navy comprises not only a substantial "fleet in being," with all its auxiliary services and shore-based supports, but also, at least at present, a large and active program of new construction. This, of course, would be expanded greatly on threat of war so that except for such expansion and maintenance of the fleet on a war basis, the procurement problem of the Navy in war time would not be so greatly different from that in peace time.

Therefore, our problems of expansion to suit war conditions, while unquestionably considerable, probably would be nowhere near so great as those which would confront the Army. In other words, the transition from a peace to a war footing is possibly less difficult for the Navy than for the Army—owing to the fact that the upbuilding and maintenance of the fleet and the naval establishment in time of peace engage the same general types of manufacture as would be required in war, the chief difference being in the expansion required to meet greatly increased quantity, but not change in character, of output.

Diesels and Defense

Advantages of the Oil-Burning Engine for Military Use

By Walter C. Sanders*

ALL-AMERICAN Diesel and other types of oil-burning engines with all-American fuel-injection equipment now are available in types and sizes suitable for military purposes. Their manufacturers are ready and eager to cooperate with the military authorities in adapting these engines to military requirements.

The modern oil-burning engine has many important advantages for military transportation service. First of all it is *safe*. The greatest safety factor of the oil-burning engine lies in the fuel it burns. What would happen if all those now using fuel oil to heat their homes suddenly had to change to gasoline? No matter how many safety precautions were taken, there would be a large number of explosions and fires with disastrous results to life and property.

The greatest virtues of gasoline as engine fuel—its inflammability and explosiveness—are also its greatest disadvantages in military automotive vehicles engaged in modern warfare. Fuel oil leaking into the bilge of a boat may be unsightly, but it is not dangerous. Gasoline in the same spot may not show up but certainly will make itself known with the first stray spark or carelessly dropped match. Huge concentrations of gasoline or Diesel-engine fuel oil will be required by mechanized armies depending upon them for fuel in future wars. These concentrations, especially gasoline dumps, will receive special attention from enemy bombing airplanes. With the ever-increasing flying ranges of modern bombers and the possibility of long-sustained flights, as exemplified by the Hughes around-the-world flight, it is doubtful if concentration points for gasoline would be safe against attack at even remote points. A single direct hit could send thousands of gallons of gasoline up in flames with terrific incidental destruction. Furthermore, a carelessly discarded cigarette or an accidental spark easily could cause a disastrous explosion at any time. It is easy to see how badly an army could be crippled in this manner. An incendiary bullet fired into the gasoline tank of a vehicle would mean the loss of that piece of equipment and serious injury to its occupants. Fired into a tank of fuel oil, it would mean a leak—nothing more.

Fuel oil used in modern oil-burning engines is free from these fire hazards. It will explode only when properly atomized and injected into engine cylinders. It is difficult to ignite otherwise and burns slowly even under the most favorable conditions. This is a vital reason why military authorities can seriously consider the adoption of oil-burning engines for all mobile military equipment—transportation, construction, and combat. Fuel oil is safe to store, transport, and use.

THE oil-burning engine is *economical*. Economy is the watchword of the day. The inherent economy of the oil engine should be utilized—not necessarily the economy based on the present cost differential between fuel oil and gasoline, but the economy based on the oil engine's ability to do nearly twice as much work or go nearly twice as far on a gallon of fuel as the ordinary gasoline engine. Today we are reveling in an abundance of natural domestic crude oil but experts agree that it cannot last forever. However, conservation of our crude-oil deposits or reduction in the costs of distillation are not the only things to consider. There is also the economy of safety which makes itself evident at every turn when fuel oil is used as a fuel. Insurance costs go down, handling and storage costs go down and equipment losses due to fire or explosion are practically eliminated. Moreover, oil-burning engines so completely utilize and consume the fuel they burn that their exhaust is almost entirely free from poisonous carbon-monoxide gas.

We have said that oil-burning engines are economical because they make the equipment in which they are used available for a wider range of work. This is due to the fact that they have better torque characteristics than comparable gasoline engines. With oil-engined trucks, point-to-point running times are less, driver fatigue is less, and accidents occur less frequently. With the same amount of fuel, an oil-engined truck can travel nearly twice as far as a gasoline-engined truck of the same weight. With only half the fuel it can go as far as the gasoline truck.

THE higher efficiency of the oil-burning engine is of great importance not only because of the economy of operation but also because of the smaller amount of fuel that needs to be transported. For instance, if a certain military operation required the transportation of 500,000 pounds of fuel oil into the military zone, 1,000,000 pounds of gasoline—twice as much—would have to be transported for the same purpose if gasoline were used for fuel. Reduction in the amount of material necessary to transport into the military zone is of great importance.

The oil-burning engine is *efficient*. Oil-burning engines already are an important factor in the marine field and many large ocean-going ships daily are making operating records. The principal advantages of the Diesel engine from an efficiency standpoint are as follows: It will do nearly twice as much work on a given amount of fuel as a gasoline engine. It uses a fuel which at the present time is not only safer but cheaper than gasoline. It has bulldog tenacity in "holding on" to a load; that is, it has better torque characteristics than the common gasoline engine. Oil-burning vehicles can climb hills faster and are easier to drive than their gasoline-engined counterparts.

Oil-burning engines are piling up millions of miles and hundreds of thousands of hours of satisfactory service at the present time and the consensus of opinion among the larger operators is that service inspections need be made at no more frequent intervals than is necessary with gasoline-powered equipment, that breakdowns are no more frequent and maintainance, properly handled, is no more expensive.

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FINALLY, the oil-burning engine is easy to maintain. The maintainance of modern oil engines has proved to be no more difficult than that of ordinary gasoline engines. Moreover, the cloak of mystery which for years has hampered the progress of the oil engine has been thrown aside, and today anyone familiar with engines in general can service and operate an oil engine. These engines run cooler than gasoline engines, which means that valves do not need regrinding nor cylinders rehoning as often. There is no delicate, complicated electrical equipment to get out of order. They start easily, run smoothly, and accelerate rapidly.

Either 2- or 4-cycle oil engines are available to meet the requirements of particular installations. Recently the light high-speed 2-cycle engine has become a factor in the smaller-engine field which formerly was dominated by the 4-cycle type of engine. This means that all types and sizes of engines for every installation now are available.

The majority of Diesel engines built in America formerly were based on European experience. At the present time, however, purely American designs of engines and auxiliaries are becoming predominant since they have proved even more satisfactory than European designs. This especially applies to important Diesel-engine accessories, such as the fuel-injection pump, starting equipment and lubrication system.

Diesel-engine development of the future probably will be toward a medium- or high-speed unit whose parts may be manufactured economically on production lines. As a result, engine prices will be governed largely by the total engine output of a given plant.

Diesel-engine fuel has become available universally; trained operators are numerous, and great advancements have been made in the design of oil-burning engines and their equipment, so that now they are no more difficult to service than gasoline engines—even to the man who is not specially trained. Fuel-injection equipment may be taken as an example of this simplification. Where only a few years ago the servicing of this equipment—the "heart" of the oil-burning engine—was shrouded in mystery and fraught with expense, today fuel-injection equipment is available which anyone can understand and service with about the same effort as removing and replacing a spark plug. This important step forward has been brought about mainly by the entry of several American manufacturers into a field hitherto dominated by foreign-built equipment.

The development of high-grade and efficient auxiliaries has made possible the modern Deisel engine. One of the factors which hitherto has limited the top speed of present-day Diesel engines is fuel-injection equipment. Modern fuel-injection equipment has made the high-speed Diesel engine possible. Considerable improvement is being made in this equipment. With past experience and mechanical and hydraulic data at their disposal, American manufacturers are developing equipment which will enable the Diesel engine to equal or surpass the gasoline engine in the matter of speed range.

Further progress in the Diesel engine will be toward a constant refinement of designs and the continued use of high-grade material and trained shop labor. The latest information indicates that there are now about fifty-five companies in the United States building Diesel engines.

There is some difference of opinion as to the type of fuel oil that should be used in the Diesel engine, but this problem is being adjusted by the coöperation of the engine builders, oil companies, and the engine operators. Diesel-engine fuel data, which are scattered and fragmentary, are being tested, coördinated, and compiled for the benefit of all concerned. The fuel-oil companies and engine manufacturers are extremely interested in this problem from the standpoint of obtaining the maximum service from oil engines, and to this end are coöperating with each other and with other interested organizations to the ultimate benefit of the engine operator.

Another important advantage of the Diesel engine is that it is not affected by weather conditions since it has no delicate electrical apparatus to become out of order. Furthermore, the Diesel engine does not have to be "shielded" to permit the efficient use of radio communication. It is a problem to shield the gasoline engine when used in military vehicles to permit the operation of the now vital military radio communication system. Due to the greatly increased mobility of mechanized armies, the importance of radio communication, free from all interference, cannot be underestimated.

WHEN all the foregoing advantages of the oil-burning or Diesel engine are considered, the question naturally arises, why has the application of oil-burning engines to motorized equipment proceeded at such a slow pace to date? One reason has been that a sufficient range of oil-engine sizes and types has not been available until recently. That obstacle no longer exists.

Since 1824 when Sadi Carnot first outlined the principle, through the long years at the turn of the century when Henry Ackroyd Stuart and Rudolf Diesel struggled to build the first commercially practical oil engines, up to the present time, there have been many minds and many millions of dollars employed in the development of practical oil engines which would justify for them a preëminent place in the nation's motorized equipment. Today, high-speed oil-burning engines are available for automotive, industrial, and stationary use in sizes from three horsepower up. The automotive-type engines compare very favorably with gasoline engines in mounting dimensions, speed, and power. Weight per horsepower is higher, but is being reduced. Initial cost is higher but this will come down as production goes up. In any event, a higher first cost is certainly justifiable at the present time in view of the outstanding advantages offered by this type of engine in operating economy, safety, and "availability."

At the present time, great progress with Diesel engines and trucks is being made in Germany and France—Germany having over 8000 Diesel trucks and France over 7000. Great Britain has over 4500. To the United States belongs the credit for the first commercial Diesel engine to be put into regular service. This engine was a 60-horsepower, 2-cylinder unit built at St. Louis in 1898.

Why then are these engines not already in use? Because only through comparatively recent developments have they become entirely practical from all standpoints. Why should not their use increase at a faster pace? It should. Where can they be used? In every piece of the nation's motorized equipment. Trucks, tanks, scout cars, buses, boats, ships, airplanes, generating sets, pumping units, power units, derricks, cranes, barges, etc.—in short, wherever a gasoline engine has been used before.

Historic Military Firearms

As Preserved in the Bowie Collection at Fort McHenry

By Richard D. Steuart*

THE late E. Berkley Bowie of Baltimore, Md., devoted his life to gathering firearms used in the various wars in which the United States has engaged. He amassed a model collection, known among collectors for its completeness and for the excellent preservation of the individual specimens. Upon the death of Mr. Bowie in 1934, his brother, Allen Bowie, turned the collection over to the Society of the War of 1812 in Maryland.

The Society, through its president, James E. Hancock of Baltimore, who had been active in the restoration of old Fort McHenry, birthplace of "The Star Spangled Banner," placed the collection as part of its exhibit in one of the old barracks at the fort. It would be difficult to imagine a more harmonious background for such an exhibition. The National Park Service has arranged the specimens in chronological order and both the method of display and the preparation of the labels are deserving of high praise.

Every weapon is under glass—the long arms in standing cases in the center of the long, low-ceilinged barrack room, and the pistols and carbines in wall cases. The guns rest on glass shelves, so that shadows are reduced to a minimum, and the visitor is enabled to note every detail of the weapon and to read the armory markings—something every collector yearns to do but is denied in most museum displays.

On the right as one enters the barrack-room door from the parade ground of the old star fort is a large case containing arms of the Colonial and Revolutionary War period. This case contains a matchlock pistol—the only matchlock in the entire collection. There is a fine example of the British "Brown Bess" musket, a British flintlock pistol of the period, a French flintlock pistol, model 1777, and other arms.

Of particular interest is the next case, which is devoted to weapons used in the War of 1812 in which Fort McHenry played such an important part. There is a fine Springfield flintlock musket, model 1798—the first model made at the Armory—and a Harpers Ferry rifle, model 1800—the first American military rifle made by the Government. It is recalled that one battalion on duty at Fort McHenry during the bombardment by the British fleet, September 13-14, 1814, was armed with this model rifle.

The second model United States musket (1808) is represented by a Springfield piece and by the products of other manufacturers, notably the Virginia Armory at Richmond (Fig. 1). This Virginia Armory, by the way, was one of the oldest in the country. In 1797, John Clarke was commissioned to build the armory. He visited Boston and other New England arms centers and was much impressed by Eli Whitney's system of uniformity of parts. Erection of the armory began in 1801, and George Williamson was appointed master armorer. Manufacture began in March 1802, and by October 1803, 2151 muskets had been finished. In 1807, Clarke wrote the governor that he had in storage 3272 muskets, 14 rifles, 470 pistols, 405 cavalry swords, 50 artillery swords and 12 powder horns. (See Bruce's "History of the Iron Industry in Virginia": p. 114 *et al.*)

The manufacture and repair of arms was carried on at the armory until 1843, the models being changed to keep abreast of the times. In the Bowie collection are several varieties of the Virginia Manufactory muskets, beginning with the 1808 model.

Other cases show the development of military firearms from the War of 1812 period to the close of the Mexican War. This group includes the Hall rifle, the first American breech-loading military rifle (Fig. 1). Later on, Simeon North improved upon the breech mechanism of the Hall rifle. Both types are shown in the Bowie collection. To this period, also, belong the model 1817 flintlock rifle (Fig. 1) and the model 1841 percussion rifle, the latter known variously as the Yaeger, the Harpers Ferry, and the Mississippi rifle. The last name was most popular and originated in the fact that the First Mississippi Volunteers, commanded by Jefferson Davis in the Mexican War, were armed with this weapon.

THE Mississippi rifle enjoyed a great popularity for many years and was a powerful and effective weapon. It is a matter of record that many duels were fought with this gun, which was caliber .54 and had a muzzle velocity of about 1800 feet per second. At first a spherical ball with patch was used, but later a conical ball, with or without a hollow base, was adapted for use in the rifle. Thousands of these Mississippi rifles were made at Harpers Ferry, and they also were made under contract by North, Whitney, Remington, Tryon and Robbins & Lawrence. Just before the War of the Sixties, many Mississippi rifles were altered to caliber .58; some were fitted with saber or angular bayonets and others were converted into breechloaders by the Merrill or Morse system. Various types of the Mississippi rifle are in the Bowie collection.

Also in the 1812-1848 cases are the United States model 1836 flintlock pistol, made by A. Waters of Milbury, Mass., and R. Johnson; the 1816 and 1819 model pistols made by Simeon North, and the 1842 model pistol—the last-mentioned being the first regulation percussion pistol of our Army.

The development of the modern military rifle is well illustrated by the group containing the German needle gun of the Franco-Prussian War, the Swiss Vetterli magazine rifle and the Lee and Krag rifles of our own Army. In another case are shown rifles used in the World War, such as the various types of Mauser rifles and carbines, the Springfield, the Springfield-Enfield and the Ross Canadian rifle.

Among the most interesting specimens, from an historical point of view, are the rifle and musket (Fig. 2) made by the Palmetto Armory, of Columbia, S. C. In 1852, when South Carolina first had the secession urge, the State Legislature gave William Glaze of Columbia a contract to make muskets, model 1842; rifles, model 1841, and pistols, model 1842, for the State militia. Glaze got his arms-making machinery from

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Waters of Milbury, Mass., and turned out hundreds of excellent rifles, muskets, and pistols, which did the South good service ten years later. Sherman wrecked the Palmetto Armory when he captured Columbia on his march to the sea.

ANOTHER gun with a history is the Plymouth rifle, designed by Adm. John A. Dahlgren, who invented the cannon bearing his name. The Plymouth rifle has a short barrel with a large bore, and is loaded with buckshot. Its most unusual feature, however, is a Bowie-knife bayonet, short and heavy. The weapon was made by Eli Whitney, and was well advertised by its inventor, who apparently had great faith in the knife bayonet as a weapon for on June 6, 1864, Dahlgren issued the following order: "Boat crews must have small arms loaded with buckshot and Bowie knives." (See Records of the Union and Confederate Navies: Vol. XV, p. 510.) Another order of Dahlgren's, issued June 14, 1864, directs the "watch on deck to have Bowie knives in their belts" (*Idem:* p. 523), and a later order says: "In changing the watch let each man show his Bowie knife. Remember that the play of this weapon is the thrust" (*Idem:* p. 549).

The Admiral thus describes his arm: "The new Navy rifled musket is known as the Plymouth Musket, because the first of the kind were made for the U.S.S. Plymouth under my command, the pattern of which was got up by myself as the most suitable for sea service. It is a short musket about 34 inches in the barrel, bore .69 and rifled. Its special bayonet is a short, broad and stout knife of the well-known Bowie-knife pattern, the principal use of which I designed to be used in the hand in close conflict as in boarding. . . . In charging artillery the sole arm will be the Bowie knife" (*Idem:* p. 623).

Two shots from one barrel was for centuries the dream of gunsmiths and armorers. It was tried out in the days of the ancient wheel lock and it was still considered good as late as 1860 when the Lindsay 2-shot rifle was patented. This gun, one of which is in the collection, was made at the Springfield Armory, which shows that Army officers had a good opinion of it. One charge was put in the barrel on top of the other and a pull of the trigger fired first one and then the other—presumably the front charge first. But in practice it did not work out so well.

After Mr. Bowie had been collecting for ten years or so, he reached the conclusion that comes sooner or later to every sincere, intelligent collector—that a certain amount of specialization is necessary; hence he selected 1861-1865 as the broadest and most interesting period for his time and talent. As a result, I believe that Fort McHenry now has the best public museum collection of firearms made and used in the Confederacy, and few private collections surpass it in that particular.

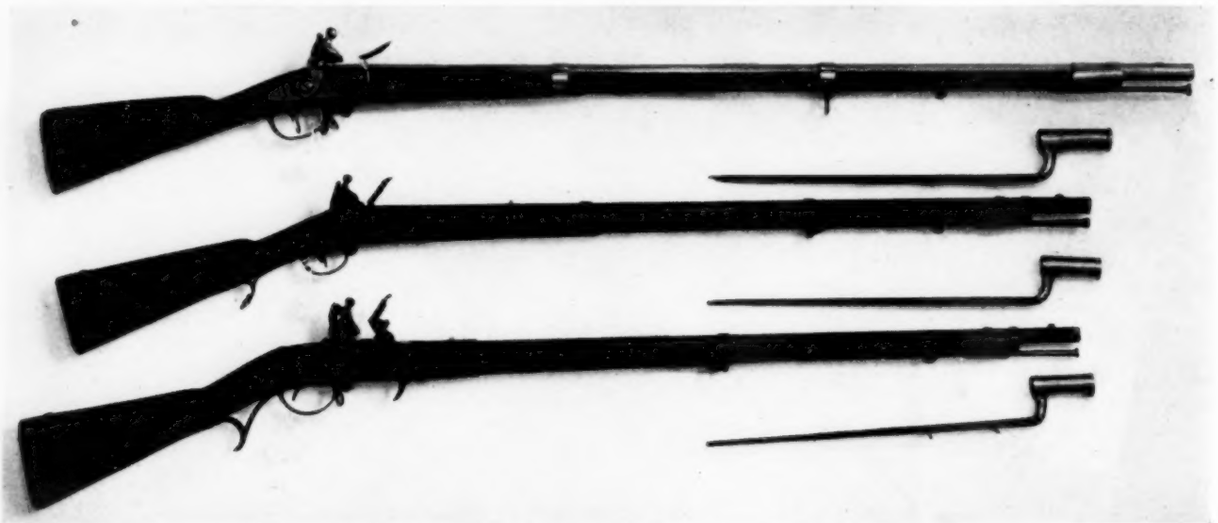

FIG. 1. A UNITED STATES FLINTLOCK MUSKET AND FLINTLOCK RIFLES

Top: Flintlock musket, model 1808, made at Virginia Manufactory, Richmond, 1817; caliber .69; iron flashpan; top of barrel stamped "P"; lock stamped "Virginia Manufactory, Richmond, 1817"; all parts stamped "33"; has bayonet stamped "7". *Center:* U. S. flintlock rifle, model 1817; caliber .52; made by S. North, Middletown, Conn., 1825. *Bottom:* U. S. flintlock, model 1819; caliber .50; first breechloader used by the U. S. Army; also called the Hall rifle.

THE greatest problem that confronted the "war-cradled nation" in 1861 was to arm its volunteers. In the various arsenals of the South were about 150,000 shoulder arms, of which only 20,000 were modern rifles. The others were flintlock muskets and rifles of the Revolutionary War and the War of 1812, percussion muskets altered from flintlocks, and some few of the model 1842 muskets. Within the limits of the Confederacy there was no armory or gun manufactory with modern machinery, except the Harpers Ferry Armory. To arm and equip its forces, the South had five sources of supply open—conversion of privately owned sporting arms, manufacture, purchase in the North, purchase abroad, and capture.

In May 1861, Maj. Caleb Huse was sent to England to buy Enfield rifles for the Confederacy. Major Huse contracted with the London Armoury Company and other firms, and the rifles were rushed to the South by blockade runners. In September 1861, a lot of 3500 Enfields was received and these weapons were in the hands of Southern troops in time for the battle of Shiloh in April 1862. Major Huse also went to Vienna and bought 100,000 short Austrian rifles, which were sent to the Confederacy. So efficient was the blockade-running service of the South, that General Gorgas, the Con-

federate Chief of Ordnance, reported on February 3, 1863, that Major Huse had sent to the South 70,800 long Enfield rifles, 9715 short Enfield rifles, 354 Enfield carbines, 27,000 Austrian rifles, 21,400 British muskets and 2020 Brunswick rifles.

Austrian rifles (Fig. 3) with saber bayonets were in the hands of Lee's infantry at the Battle of the Wilderness. The cadets of the Virginia Military Institute, who gave such a good account of themselves in the Battle of New Market, May 11, 1864, were armed with Austrian rifles. (See General Smith's report, Official Records: Vol. XXXVII, Part I, p. 730.) The long Enfield was the most popular infantry arm in the Confederate Army, and the short Enfield made a fine cavalry weapon. The Enfield was caliber .577, but it would take a caliber .58 cartridge. Virtually all these weapons are represented in the Bowie collection, except that there is no saber bayonet for the Austrian rifle. Lee's soldiers found the bayonets so unwieldy that they threw them away.

FIG. 2. UNITED STATES PERCUSSION MUSKET (CENTER) MADE AT PALMETTO ARMORY, S. C., 1852

Browned barrel 3 feet, 6 inches long; caliber .69; lock stamped "Columbia S.C. 1852"; brass butt stamped "S.C."; side of barrel stamped "PV William Glaze & Co." and a palmetto tree; top of barrel stamped "S.C." (*Top:* U. S. percussion musket, model 1861; caliber .58. *Bottom:* U. S. percussion rifle, model 1841; caliber .69; converted to a breechloader by the Merrill system.)

CAPTURE of the Harpers Ferry Armory in April 1861, was a fortunate stroke for the Confederates. The fire set by the Union soldiers guarding the plant destroyed the carpenter shop and about 17,000 finished rifles and muskets, but virtually all the gun-making machinery and a great store of gunstocks and gun parts were saved. The State of Virginia claimed all this property, but it was agreed that North Carolina should have the rifle-making machinery for use at Fayetteville, where there was good steam power—this machinery to be returned at the end of the war.

The machinery for making the rifled musket was removed to Richmond and set up in an old tobacco warehouse under the direction of Col. James H. Burton, whose experience in the United States armories and in the erection of the famous rifle works at Enfield, England, made him invaluable to the South. The Richmond armory began production in September 1861, and soon began to turn out 1000 rifled muskets a month, mostly from parts rescued at Harpers Ferry. The lock plates had been forged for the Maynard primer, but were put together in Richmond without the tape lock. Soon, however, the supply of iron butt plates and trigger guards gave out, and most of the Richmond-made rifled muskets of 1863 and 1864 are found with these parts of brass. Specimens of these Richmond rifled muskets, made up of the captured parts, are in the Bowie collection.

The machinery for making the Harpers Ferry rifle, was set up in the Fayetteville Arsenal and was put to work in the spring of 1862. It averaged 400 rifles a month at its maximum capacity. It is interesting to note that these Fayetteville rifles (Fig. 4), two fine examples of which are in the Bowie collection, had their lock plates stamped with the die used at Harpers Ferry. This die was originally for the model 1841 rifle, caliber .54, and showed a small eagle, regard to left, shield on breast, three arrows in right claw, laurel in left, with the letters "U.S." below. At Fayetteville the "U.S." was cut out with a plane or lathe to a depth of one-eighth of an inch and the letters "C.S.A." in type were keyed in place. The "S" was put in upside down, as readily may be seen. After the war, the rifle-making machinery, including the die, was hidden, but was found by the Union troops. The first Fayetteville rifles of 1862 and 1863 are fitted with a saber bayonet. Then came a War Department order directing that no more saber bayonets be manufactured, and we find the Fayetteville rifles of 1864 without the bayonet stud.

Of the private gun manufactories in the Confederacy, the largest was that of Cook & Brother. Ferdinand W. C. Cook and his brother, Frank Cook, were Englishmen who had a foundry in New Orleans. In October 1861, the Cooks began the manufacture of guns on the Enfield model. Just before the fall of New Orleans the plant was turning out twenty guns a day. When Farragut's fleet passed the forts, the Messrs. Cook loaded their gun-making machinery on steamers and escaped with it. The plant was removed to Athens, Ga., where a brick factory was completed in 1863. Here the output was 300 guns a week. Maple and walnut were used for stocks, and household brasses were contributed for the mountings, which explains the fine quality of brass found on all Cook & Brother guns.

FIG. 3. AUSTRIAN RIFLE (TOP) AND CONFEDERATE PERCUSSION RIFLE, 1863 (CENTER)

Austrian rifle is a Werndl, browned barrel 2 feet, 6 inches long; caliber 11 mm.; lock stamped "Greinel M 868"; top of barrel stamped "Werndl" with "ELG" and star in circle; bayonet has 22½-inch blade and 5⅛-inch grip. Confederate rifle has a barrel length of 2 feet, 11 inches; caliber .60; lock stamped "CS 1863 M.J.&G. N.C."; iron butt; brass guard, foretip, and bands. (*Bottom:* Confederate naval percussion carbine; caliber .60.)

The guns were made in three models—a rifle with 33-inch barrel, an artillery carbine with 23-inch barrel and a cavalry carbine with 20-inch barrel and swivel ramrod. Fine specimens are in the Bowie collection. The Cooks were real patriots. Near the end of the war, they organized their mechanics into a defense battalion. This battalion put up a hard fight opposing Sherman, and Maj. Ferdinand W. C. Cook was killed at the head of his men in one of the engagements before Savannah in December 1864.

The two rarest Confederate rifles in the Bowie collection are one made in North Carolina and another made in Georgia. The first is the Mendenhall, Jones & Gardner rifle. Cyrus E. Mendenhall, Ezekiel P. Jones, and Nathan Gardner began the manufacture of guns in a frame building on Deep River, about a mile from Jamestown, N. C., in the spring of 1862. They employed about eighty operatives. The rifle they made was on the Mississippi model, caliber .58 with saber bayonet, and was stamped on the lock plate: "M.J.&G., N.C. C.S." and the date of manufacture. The output was small, and the guns are found in few museums and collections. (See Fig. 3.) Perhaps the most interesting feature of the rifle is the saber bayonet, which is like that used on the English Lancaster rifle. The Bowie specimen lacks the bayonet, but the one in the National Museum in Washington is fitted with the Lancaster-type bayonet.

The rare Georgia rifle in the Fort McHenry exhibit is that made by Greenwood and Gray, at Columbus, Ga. It, too, is on the Mississippi rifle model, with 33-inch barrel but not equipped with a bayonet. It was stamped on the lock plate with the name of the master armorer, "J. P. Murray." Murray was an Englishman and an expert gunsmith. After the war he resided in Charleston, S. C., where he died about 25 years ago.

ANOTHER interesting Confederate rifle in the collection is that made by the Shakanoosa Arms Company and stamped on the lock plate "Dickson, Nelson & Co. Ala" and the date of manufacture (Fig. 4). In 1861, William Dickson, of Dickson, Ala., O. O. Nelson of Tuscumbia, Ala., and L. H. Sadler, of Leighton, Ala., organized the Shakanoosa Arms Company and were awarded a contract to manufacture "Mississippi rifles" for the State of Alabama. They began to build a plant at Dickson, but before it was completed the tide of war changed, and the firm moved hastily to Rome, Ga.

There they leased a large brick building, but hardly had gotten under way when fire, believed of incendiary origin, wiped out the plant. The harassed firm next moved to Adairsville, Ga., where rifles were manufactured until after the battle of Chicamauga. The next move was to Dawson, Ga., where rifles were made until the end of the war. And so these guns that bear the name of Alabama, all were made in the neighboring State of Georgia.

Of the five breech-loading carbines manufactured in the Confederacy, the Bowie collection contains four models. The commonest of these is the Sharps-model carbine made in Richmond by Samuel C. Robinson. Before the war, Robinson operated the Belvidere Planing Mills. He first was awarded a contract to manufacture revolvers. Then he formed the S. C. Robinson Arms Manufactory and began the manufacture of carbines on the Sharps model.

General Gorgas, the Confederate Chief of Ordnance, reported on September 30, 1863, that 3000 carbines had been made there since September 1862. But the carbines were so poorly made that many of them burst. The arms were not gas-tight and spat fire at every discharge, so that the men were afraid of them. General Lee in a letter to Gorgas in June 1863, said the carbines were "so defective as to be demoralizing to our men." (See The Confederate Veteran: Vol. 27, p. 265.)

Under the caption "An Outrage," the Richmond *Whig* of March 30, 1863, says in an editorial: "A correspondent, a Lieutenant of Cavalry, writes us from Culpeper C. H., March 23 as follows: 'Forty new Sharps rifles with Richmond stamp on them were handed yesterday to my company. The men were ordered to test them. Nine were fired, and seven of

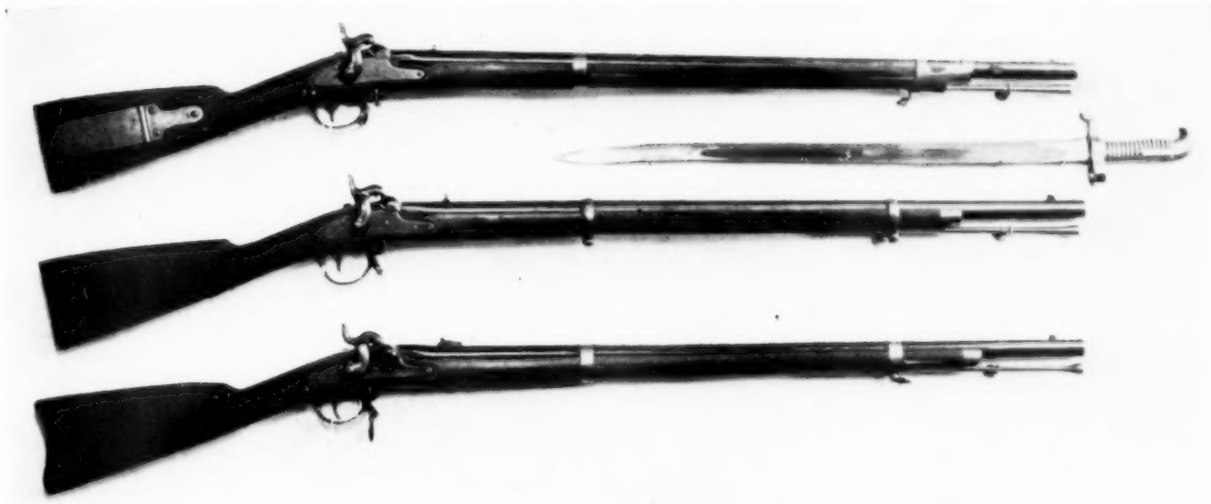

FIG. 4. DICKSON, NELSON & CO. RIFLE, 1863 (CENTER) AND FAYETTEVILLE RIFLE, 1863 (BOTTOM)

The Dickson, Nelson & Co. rifle is a Confederate percussion rifle; barrel length, 2 feet, 11 inches; caliber .60; lock stamped "Ala. 1863, Dickson Nelson & Co. C.S."; left side of stock stamped "J.S. Crossy"; brass butt, guard and bands. The Fayetteville is a Confederate percussion rifle; lock stamped "1863 Fayetteville" with "CSA" under American eagle; brass butt, guard, bands, and foretip; top of butt stamped "CSA"; bands stamped "U". (*Top:* U. S. rifle, model 1841; caliber .52.)

the nine burst.' The Lieutenant suggested that the manufacturers of these arms be sent to the field, where they can be furnished Yankee sabers, while the iron they are wasting can be used for farming implements."

The Government finally bought out the Robinson carbine plant and converted it into a factory for the manufacture of muzzle-loading carbines.

Then there is the Morse breech-loading carbine (Fig. 5), another poorly made and impractical weapon, because it required special ammunition. George W. Morse, who had been granted a patent for a metallic cartridge in October 1858 and had invented a breech-loading system which had been applied to arms then in use, set up a factory at Greenville, S. C., in 1863. There his principal work was the manufacture of a light, brass-frame carbine, caliber .50, using a metallic cartridge. Many of these carbines were issued to the cavalry, but soon found their way back to the arsenals because of the difficulty of getting proper ammunition. Four hundred Morse carbines were found in the citadel at Columbia, S. C., when the Union troops captured it in 1865. (See Official Records: Vol. XLVII, p. 181.)

The other two Confederate breech-loading carbines in the collection are a puzzle to historians. The one is a weapon which has been called by collectors the "Confederate Perry" (Fig. 5). It is caliber .50 with brass frame, and well made. But "Perry" is obviously a misnomer. The carbine is made on the Maynard model. In the Camden (S. C.) *Journal* of May 31, 1861, I find a note that G. B. Schriver, gunsmith, had built a "breech-loading rifle upon the same principle as the Maynard." And in a number of Southern newspapers of June 1864, I find the statement that "the carbine factory at Tallassee, Ala." is "engaged in making carbines for the cavalry chiefly of the Maynard patent and fully equal in workmanship to the best product of Yankeedom."

The fourth and last of the Confederate breech-loading carbines in the Bowie collection is even more of a mystery. It is a well-made weapon, caliber .50, with a breechblock that rises vertically when an under-lever is depressed. It bears no marks except "C.S." and "P" on various parts. There are a number of these carbines in public and private collections, but no one seems to know anything about their origin. Mr. Bowie had an interesting theory about these carbines, but one which he never was able to support by documentary evidence. He believed this carbine was the "Read rifle" mentioned frequently in Confederate ordnance reports. N. T. Read of Danville obtained a patent for a breech-loading firearm on March 20, 1863. The manufacture of these carbines was begun, and it is on record that fifty were completed and sent to the 5th Virginia Cavalry. They proved worthless, many of them bursting on the first shot, and were discarded.

UNFORTUNATELY for Mr. Bowie's theory, however, I find mention of "Read's cavalry rifles" in the early part of the war. The report of the Virginia Armory at Richmond shows that 596 Read's rifles were issued to troops in the year ending November 1, 1862, and 220 more in the year ending October 1, 1863. Also, that the armory had on hand on October 1, 1863, 400 of these rifles.

The Civil War brought out scores of breech-loading devices, most of which were applied to carbines. Many of these weapons are in the Bowie collection. Perhaps the rarest is the Merrill, Latrobe & Thomas carbine. The patent for this breech-loading device was granted to James H. Merrill, Baltimore gunsmith, in 1858. Associated with Merrill in the enterprise were Philip E. Thomas and John H. B. Latrobe, both men of prominence in Baltimore. The first models were made by Remington and were loaded from beneath and fired with a Maynard primer.

Additional patents were granted to Merrill, and his device was approved by Army experts. Many Harpers Ferry rifles and Springfield musketoons were fitted with the Merrill breech mechanism (See Fig. 2). Latrobe dropped out of the firm, which became Merrill, Thomas & Company. About 1863 the Union authorities became suspicious of the political leanings of Merrill and Thomas and confiscated the store in Baltimore. The Merrill carbines and rifles apparently never

Fig. 5. "Perry" Percussion Carbine (Top) and Morse Breech-Loading Rim-Fire Carbine, 1863 (Center)

The "Perry" has a rifled barrel 1 foot, 8 inches long; barrel stamped "PP". The Morse has a barrel length of 1 foot, 8 inches; caliber .53; made by L. Morse in 1863; brass butt, receiver, and guard; brass tipped ramrod; hinged receiver; under receiver is stamped "643"; left stock carved "16". (*Bottom:* Spanish Mauser carbine, model 1893; caliber 7 mm. used by Spanish Army in the Spanish-American War.)

were made in Baltimore. They probably came from the Remington plant.

The Bowie collection also illustrates the transition from single-shot to multishot military long arms which came about during the War Between the States. The first repeating shoulder arm used was the Colt revolving rifle and carbine. These weapons had a cylinder, like a revolver, and carried five or six shots.

Next came the Henry repeating rifle, which carried 11 short metallic cartridges, caliber .44, in a tube beneath the barrel. This was followed by the Spencer rifle and carbine, caliber .52, which carried a tube of metallic cartridges in the stock. The Spencer was the best of the three. General Ramsay, Union Chief of Ordnance, reported August 9, 1864, that he had purchased since the first of the year, 20,182 Spencer carbines, 11,470 Spencer rifles and 2000 Henry rifles and had contracted for 77,100 Spencer carbines. In spite of the protests of General Ripley, Union Chief of Ordnance, who in 1861 disapproved of metallic-cartridge arms because they called for special ammunition, the day of the muzzle-loading gun, shooting a paper cartridge, was past.

DURING the war, the North bought 94,000 Spencer carbines and 11,471 Spencer rifles, and about half of these were delivered in time for actual use. The 5th Michigan Cavalry probably was the first unit to be armed with Spencers, which was in March 1863. The entire Michigan brigade at Gettysburg had Spencers, and of Wilson's great cavalry force of 20,000 men in 1864, all had breech-loading carbines—13,000 of them Spencers. (See Official Records: Vol. XIX, Part I, p. 354.)

Henry rifles were used by the Federals at Allatoona in October 1864. (See Gen. S. G. French, "Memoirs of Two Wars": p. 263.) Colt's revolving rifles were used by the Union troops at Chicamauga and at the Battle of Franklin, Tenn. (See Gen. Jacob D. Cox, "The Battle of Franklin": p. 111.) But the Spencer was the stouter gun and soon replaced the Henry and the Colt.

The wisdom of Mr. Bowie's choice in making a specialty of arms used in the American conflict of 1861-1865 is realized when one learns that exclusive of the million or so arms made at Springfield, the North bought 1,912,360 rifles and muskets, 407,923 carbines, and 373,971 revolvers for use in the war, and that 726,000 rifles and muskets were of foreign manufacture. About 428,000 of these were Enfields. The Union Army also used officially twenty varieties of revolvers, most of which are shown in the Bowie collection. For instance, the North purchased, in round numbers, 47,000 Starr revolvers, 11,000 Whitney revolvers, 11,000 Savage revolvers, 5000 Rogers & Spencer revolvers, 5000 Remingtons, 1100 Joslyns, and 2000 Pettingills. The North also sent to France and Belgium for 13,000 Lefauchaux, Perrin and Raphael revolvers, most of which used the pin-fire cartridge.

The Confederate Army used anything that would shoot. For instance, a statement on file in the archives of the Confederate Museum in Richmond shows the following arms in the hands of Confederate troops in September 1862: Belgian rifle, caliber .71; Mississippi rifle, caliber .54; smoothbore musket, caliber .69; rifled musket, caliber .69; Hall carbine, caliber .52; Merrill carbine, caliber .56; Sharps rifle, caliber .52; Burnside rifle, caliber .56; Colt revolving rifle, caliber .56; Colt revolving rifle, caliber .44; Maynard rifle, caliber .51; Maynard rifle, caliber .37; rifled musket, caliber .58; German rifle, caliber .69; English smoothbore, caliber .75; Enfield rifle, caliber .57.

Ordnance officers of the Civil War period, charged with the responsibility of supplying ammunition for the troops, must have had many sleepless nights!

But one man's meat is another's poison, and it is this great variety of armament that makes collecting so fascinating a game and that gives to the Bowie collection at Fort McHenry its value as an interesting and historical exhibit.

Strategic and Critical Materials

Their Relation to Our National Security, II

By Lieut. Col. H. D. Rogers*

IODINE is one of the most important drugs for field use, and no satisfactory substitute has been developed. Our progress in the production of strategic materials is emphasized by our progress in the manufacture of iodine. Formerly, sixty per cent of the world's annual production of iodine was produced in Chile and twenty per cent in Scotland. Relatively small amounts were produced in Japan, France, and Java. World production and trade in iodine have undergone significant changes in recent years, with the United States, formerly dependent upon a foreign monopoly for its supplies, emerging as the world's second largest producer and capable of obtaining its entire requirements from domestic sources. The old method of obtaining this important item was from kelp; it is now produced in this country from salt-water oil wells. In 1930, prior to the utilization of domestic resources, the price of iodine was approximately $5 a pound. Since that time the price gradually has declined to approximately $1.60 per pound. This item, however, is being maintained on the strategic list because of its high degree of essentiality and because the industry is young and may encounter some difficulty in maintaining domestic production in the face of decreased price—the result of foreign imports without any protective tariff. Iodine is used as an antiseptic, as a germicide, and as a counterirritant. Salts of iodine are used in photography and analytical chemistry.

THIS is Part II of the last of a series of nine articles on procurement planning by chiefs of the various divisions of the Planning Branch, Office of the Assistant Secretary of War. Of all the factors which contribute to the military security of a country none is more basic than adequate raw materials from which the sinews of defense are made. Depending upon the freedom with which natural sources are found and the technological progress toward satisfactory substitutes, certain materials are classed as strategic and others as critical. The United States is unusually fortunate in its resources but its deficiencies, while few, are notable.

Articles already published in this series are: "The Army and Navy Munitions Board," by Col. H. W. T. Eglin (March-April 1937 issue, p. 275); "Standards for Army Supplies," by Capt. George V. McPike (May-June, p. 344); "Procurement Planning," by Lieut. Col. G. M. Barnes (July-August, p. 21); "The Allocation System," by Maj. Scott B. Ritchie (September-October, p. 77); "War-Time Contracts," by Maj. C. C. Fenn (November-December, p. 154); "Emergency Construction," by Capt. W. R. Winslow (January-February 1938, p. 227); "Priorities," by Capt. W. E. Niles (March-April, p. 289) and "Contributory Factors of Defense," by Lieut. Col. R. B. Cole (May-June, p. 351). (Part I of the present article was published in the July-August issue, p. 35. Part III will follow.)—EDITOR.

MANGANESE ferrograde ore, for use in making steel, normally is imported. Our country can produce low-grade and chemical ores but has no large deposits of the richer types. All of the high-grade manganese deposits of any quantity are located in remote countries—Russia, India, Africa and Brazil, with the exception of Cuban resources.

Manganese ores found in Russia, India, Africa, and Brazil are of high grade and require little or no treatment to make them commercially available. The ores contained in the United States deposits, in comparison, are low-grade and can be made useful in the fabrication of steel only through the development and application of expensive concentrating processes, except for the use of spiegeleisen, and for use in the tanning and chemical industries, all of which can be produced domestically. Domestic production of ore containing 35 per cent or more of manganese in 1936 was about 78,557 tons.

For the twelve months of 1936, a total of 846,648 long tons was imported, of which Russia furnished 289,867 long tons; the Gold Coast, 241,594 long tons; British India, 126,913 long tons; Brazil, 110,018 long tons; Cuba, 37,912 long tons, and all others, 40,344 long tons. In 1935, Cuba furnished 43,955 long tons and Brazil 29,528 long tons.

The Cuban industry, if properly developed, would constitute a notable asset for purposes of national defense. The patrolling of a small stretch of water between Key West and Havana would make the Cuban product as readily available as the domestic ore. The developed Cuban ore bodies constitute a great strategic reserve, with great potential capacity subject to expansion sufficient to provide, during an emergency, a substantial part of the manganese requirements of the United States.

MANILA FIBER is obtained from the stem of the abaca plant (*Musa textilis*) which is a bananalike plant of the Philippine Islands. When the plants are cut, each leaf stem is drawn under a knife blade, removing the soft pulp and leaving the clean fibers. A supply of labor is necessary for the hand drawing. The fiber is then dried, graded, and baled for shipment. The fiber is very long and is easily twisted into rope. It is used in practically all naval cordage, for which it is especially adapted, because it floats and resists the effects of salt water. Manila fiber has replaced hemp in the manufacture of ropes. The fiber may be stored for two years without deterioration. It also is used in binder twine, for wagon covers, and similar purposes.

The cordage industry is centered in the ports of San Francisco, New York, and Boston—the ports of entry for cordage. The United States consumes approximately one-third of the world's production.

There is no manila fiber produced in the United States.

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It is a tropical product. The necessity for cheap labor alone would prevent its development here, unless machine methods were developed. The commercial source is the Philippine Islands in the southern provinces of Luzon, and in Davao and Leyte. It may be grown elsewhere in the tropics, but the Philippine supply is ample and cheap.

Cotton is the most acceptable substitute but may be needed in an emergency to replace jute which is used in great quantity. Henequen is shipped to this country from Mexico in large amounts for use in binder twine. About two million pounds of domestic hemp are produced annually, and this amount can be increased. Flax is grown in large quantities in the United States but for seed rather than for fiber, as it is not especially suitable for military use. Its use in wallboard is increasing.

MICA is a crystal which is unique among minerals in the number of useful properties it contains. The automobile, airplane, and radio industries find this material practically indispensable for insulation. All grades of mica occur throughout the world, but the principal commercial sources of sheet mica are India, Madagascar and the United States, which produced, respectively, 82 per cent, 6 per cent and 5 per cent of the estimated world's production of 19,300,000 pounds in 1935.

Roughly speaking, commercial mica may be classed in four groups; namely, ground, punch, sheet, and splittings. It is chiefly with sheet mica that we are concerned, as the domestic production of the other grades is sufficient to cover the demand, except for splittings, which are imported, not because of lack of material but because Oriental material can be imported at a lower price than our high-price domestic labor would make necessary.

NICKEL is necessary to toughen steel, and the armor plate of the world is made of nickel steel. Many alloys are made of this valuable metal with copper and other metals. The greatest world's source is in Canada, with whom we always have been on excellent terms. In 1935, eighty-three per cent of the world's nickel came from the Sudbury district in the province of Ontario in Canada. Most of the remainder came from New Caledonia, with small quantities from Russia, India, and Norway. The world's annual production of nickel was approximately 75,000 tons, of which the United States imported about 38,000 tons (1935)—all from Canada.

About thirty-seven per cent of the nickel is used in steel alloys and thirty-three per cent in anodes. The remainder is used largely for plating and in nonferrous alloys, such as monel metal. Its chief military uses are in armor plate and projectiles. Nickel increases the strength and resistance of steel and tends to make it nonmagnetic and to increase its coefficient of heat expansion. There is a possibility that experiments now under way will indicate that molybdenum may be substituted to a considerable extent for nickel as a ferro-alloy. In making heat-resisting steels and many of the electric heating units, nickel is indispensable. Even our soap industry finds nickel desirable in hardening its fats and oils.

OPIUM.—Crude opium is prepared in irregular lumps or cakes of dark-brown color. There are twenty alkaloids, of which morphine and cocaine are the most important. Morphine has been classed as the most important drug in medicine for relieving pain. The drug is permanent and does not deteriorate, but finished preparations become unusable. The content of alkaloidal salts, however, can be recovered with only the losses incident to processing.

The principal world sources are British India, Turkey in Asia, and Yugoslavia. Importation is controlled by the narcotic division of the Treasury Department by allotting specific quotas to recognized importers. Shipping routes are via the Mediterranean and Atlantic sea lanes. Two-thirds of the imports are made in United States bottoms. In 1925, authority was granted the Surgeon General of the Army to accept and store in reserve, stocks of opium or preparations thereof, suitable for medicinal use, which have been seized and confiscated by the authorities. The amounts received in this manner are sufficient for all military uses in a national emergency.

OPTICAL GLASS.—The optical-glass industry has not been greatly developed in the United States, perhaps because its manufacture does not lend itself to methods of mass production. Our manufacturers are unable to compete successfully with foreign producers who have a source of cheap skilled labor. Dependence for our supply prior to the World War was placed on foreign sources, and upon the outbreak of the war we were thrown upon our own resources with little help from our overburdened Allies. As a result, ample capacity for producing this material was available by the conclusion of the war. Since that time, several of the optical-glass plants have been dismantled, but Bausch & Lomb, the largest and most efficient plant, still remains in operation.

If a policy is maintained of placing a sufficient number of unfinished optical-glass blanks in reserve each year, and if the above-mentioned sources continue production on the present scale, the position of this item will become less strategic in the future. The optical-glass industry is supplying fifty per cent of the present peace-time needs. In the other fifty per cent is included such material as camera lenses, some of which are processed here.

There is now a tariff on imports of both blanks and finished products. However, it is not sufficiently great to develop domestic production to a point where imports would be excluded.

QUARTZ CRYSTAL, as the name implies, is a natural crystalline form of quartz, used principally in jewelry, optical instruments, and radio equipment. Although quartz is one of the most common and widely distributed minerals and occurs in a variety of forms, the commercial source of quartz crystal satisfactory for frequency control in radio equipment is Brazil. Deposits reported in the past in Madagascar and Japan have not been verified.

QUICKSILVER is a metal of many uses. It is a drug and a chemical necessary in many of our industrial activities, from the production of gold to the disinfection of seeds. In the military art it is an ingredient of certain explosives, and a minute quantity serves to start on their way many of our projectiles. The greatest world sources are Italy and Spain.

QUININE and its related alkaloids, quinidine, cinchonine, and cinchonidine are obtained from the bark of the cinchona tree of which there are several species. Quinine is a specific in the treatment of malaria and is also employed as a tonic, an antispasmodic, an antiperiodic, and a diaphoretic. Quinine is usually extracted from the bark with sulphuric acid and therefore the product obtained is in the form of the sulphate.

The production and manufacture of quinine are controlled

by the Kina Bureau and the Quinine Convention. The Kina Bureau is an organization of planters and certain manufacturers, while the Quinine Convention is an association of international manufacturers. In 1928, the so-called Quinine Trust was formed in New York and brought under Government control the activities of the importers of quinine. Total world production of cinchona bark in 1929 was 1,959,891 pounds. Shipment of quinine from the Netherlands and its possessions is made in Dutch ships and from Germany in German ships. Japan now is reported producing quinine and within three years expects to be producing 900,000 ounces of the sulphate annually.

There are no substitutes for quinine, but two synthetic compounds, namely, atabrine and plasmochin, have been developed by the Winthrop Chemical Works to complement the use of quinine in the treatment of malaria. The essential chemicals in these two drugs are imported from Germany. Conservation would consist largely in eliminating the use of quinine for nonessential proprietary preparations, such as hair tonics, etc. The amount of saving cannot be estimated correctly. It is also too early to estimate any saving possible from the use of atabrine and plasmochin, provided the necessary chemicals are available. The only solution possible to insure the provision of military and civilian needs in an emergency is an adequate war reserve.

RUBBER is a vegetable material which grows in the tropics. We use over one-half the world's production, which comes from the Malay States, the Dutch East Indies and Ceylon, and are dependent upon outside sources for our supply.

None of our strategic commodities is worthy of more serious consideration than rubber. Our principal use of rubber is, of course, in automobile tires. It also serves a number of other important purposes; for example, its use in medical and electrical equipment. Ninety-four per cent of all rubber now used comes from the East Indies. Great Britain controls approximately sixty-five per cent of production in the East, the Dutch twenty per cent, and the Belgians, French, and Japanese, the remainder. We import and consume annually over one billion pounds, or about seventy per cent of the world's consumption. There is no satisfactory substitute. Guayule rubber is being experimentally produced in California in small quantities. It may be substituted for imported rubber in some cases and used with it in others. Under stress of war conditions a greater amount of reclaimed and reworked rubber would undoubtedly be used. It has been estimated that 525,000 long tons can be made available.

The E. I. Du Pont de Nemours Company of Wilmington, Del., has been producing experimentally a synthetic rubber product, DuPrene, now known as Neoprene. Other synthetic rubbers produced are Thiokol and Koroseal. Synthetic rubber is produced entirely from materials of which there is an abundance in continental United States. While the experimental work is far from complete, it has proceeded to such an extent as to lead to the hope that for most uses of rubber this new product may prove a satisfactory substitute in case of necessity. Tires made of synthetic rubber are being given service and laboratory tests to determine their durability as compared with those made of real rubber. It is not likely that synthetic rubbers, even if proved to be entirely satisfactory for this purpose, will be substituted for rubber in time of peace as the cost of the manufacture is several times the cost of crude rubber. Its availability in time of war, however, presents interesting possibilities and may be a solution to a very difficult problem.

SILK is a material usually regarded as a luxury, but it has many uses in industry. The insulation of wires and cables is an example, and in warfare it is used for the powder bags for our big guns and for parachutes for our air services. There is no domestic production of raw silk. The world's supply comes from China and Japan in the Orient and to a lesser extent from Italy and France. The United States consumes more than one-half of the world's supply.

The total annual production is in excess of 100,000,000 pounds, of which Japan produces 70 per cent, China 20 per cent and Italy nearly 10 per cent. Our raw silk imports reach a total of about 75,000,000 pounds, 75 per cent of which are from Japan.

TIN is one of the minerals which nature left out of our soil. It has become indispensable in the preservation of food, since it furnishes a protective coating on the steel from which our so-called "tin" cans are made. We use it in the manufacture of automobiles, for the making of bearings, solders, bronzes and gun metals. It can be rolled into foil and has many uses as a chemical.

The world's production of tin in 1936 was 180,000 long tons, of which we consumed 79,000 tons. Nearly 37 per cent of the world's tin was produced in the Malay States, 18 per cent in Netherland East Indies, and 13 per cent in Bolivia. Smaller quantities were mined also in Siam, China, and Nigeria to the extent of 7, 6, and 5 per cent, respectively.

TUNGSTEN.—Probably no other metal produced in such small quantity has any greater industrial importance than, and such an influence on, the comfort of the people at large as tungsten. Tungsten is used as a ferro-alloy and also in incandescent lamps. It is an essential element in certain tool steels for forming metals. Smaller quantities of this material are used in steel which has to stand excessive heat. We use annually approximately 4000 tons, of which we produce 1000, principally in the states of Colorado, Nevada, and California. The world production (1936) of tungsten was over 22,000 tons. Of this amount, 38 per cent was produced in China, 20 per cent in India, and 10 per cent in the United States. Bolivia and Burma each account for about 10 per cent of the world production. Malay States, Bolivia, and Portugal each account for about 8, 7 and 5 per cent of the world's production, respectively.

WOOL is the most important animal fiber, and the health and well-being of both the civilian population and the armed forces depend to a considerable extent upon the supply of this material. In normal times we import a considerable supply from the countries of Europe and from Argentina, Uruguay, Australia, South Africa, and Canada. In time of war, both our Army and Navy are clothed in wool. Without imports there would be serious shortages of this material. The principal military uses of wool are in the manufacture of clothing, blankets, felt, horse equipment, bunting, and flannel.

The estimated world's production of wool in 1936 (exclusive of Russia) was in excess of 3½ billion pounds. Many countries do not publish statistics as to wool produced, and estimates covering such countries as Russia and China, where much of the wool is used locally, are apt to be inaccurate.

The United States produces about 435,000,000 pounds of virgin wool each year, about two-thirds of its consumption. In addition, wool reclamation amounts to 160,000,000 pounds. The greater portion of the imported wool is used in the manufacture of items which are not essential in war time, such as carpets and rugs. There is no real substitute, but cotton and shoddy (redeemed wool) may be used to decrease consumption in an emergency.

SOME of the important critical items are:

ABRASIVES.—Production processes in manufacturing machinery include many grinding and polishing operations without the use of which highly finished and accurately sized components and products could not be made. Plate glass, steel, copper, wood, and other materials must be smoothed and polished for many purposes.

The various types may be classified as (1) High-grade natural abrasives, such as corundum, emery, garnet, and industrial diamonds; (2) Other natural abrasives, such as grindstones, pulpstones, quartz, pumice, etc.; and (3) Artificial abrasives, such as silicon-carbide abrasives.

Grinding as an operation in the metals industries is rapidly increasing in importance. Many operations which formerly required cutting now call for grinding. Closer tolerances are now demanded which require highly accurate grinding machines. This tendency is evidenced by the increased demand for industrial diamond wheels for truing grinding wheels. Both the artificial-abrasive manufacturers and the grinding-wheel manufacturers are capable of expanding production greatly. There is no lack of raw materials and on none except diamonds do we depend upon imports.

ALCOHOL.—Ethyl alcohol is used extensively in a large number of manufacturing operations. Lacquers, varnishes, wood stains, medicinal preparations, flavoring extracts, perfumes, organic chemicals, oilcloths, imitation leather, soap, embalming fluids, fireworks, matches, photographic materials, celluloid, smokeless powder and other explosives, toxic gases, dyes, ink, and fuel are a few of the articles in the manufacture of which alcohol is used.

Properly malted and fermented starchy materials upon distillation give approximately the following yields of ethyl alcohol:

Material	*Weight of One Bushel*	*Approximate Yield (95% Alcohol)*
Corn	56 pounds	2.5 gallons
Wheat	60 "	2.8 "
Rye	56 "	2.3 "
Potatoes	60 "	0.8 "

Methyl alcohol is largely used in the manufacture of formaldehyde, in some of the important dye materials, as a denaturant for ethyl alcohol, in paint and varnish removers, as a vehicle for shellac and other varnishes, in the manufacture of artificial leather, celluloids, pyroxylin plastics, lacquers, enamels, stains, antifreeze and general solvent mixtures.

Ethyl alcohol is produced chiefly in the United States by direct fermentation and distillation from raw products, and recovery as a by-product. The important raw materials employed in the first method are blackstrap molasses and grains. Methyl alcohol is obtained from the hardwoods—oak, beech, and maple—by destructive distillation.

Except for the use as a solvent in special cases, there is no substitute for alcohol (ethyl).

United States production of alcohol in 1929 was approximately as follows: ethyl alcohol, 206,664,000 proof gallons; ethyl alcohol, denatured, 114,516,000 wine gallons; methyl alcohol, crude, 6,945,000 gallons; methyl alcohol, synthetic (1930), 7,589,000 gallons.

In 1936, these amounts were as follows: ethyl alcohol, 197,169,000 proof gallons; ethyl alcohol, denatured, 98,618,000 wine gallons; methyl alcohol, crude, 5,575,000 gallons; methyl alcohol, synthetic, 25,564,000 gallons.

Industrial alcohol has risen in the past twenty-five years from a position of obscurity to its present rank as one of the indispensable raw materials of American industry.

The following list, showing the materials used in American alcohol production during the year ending June 30, 1926, illustrates the wide variety: molasses, 267,404,218 gallons; corn, 7,948,184 bushels; rye, 12,678 bushels; malt, 641,032 bushels; raisins, 10,705,920 pounds; rice, 724,100 pounds; hops, 71,508 pounds; sugar, starch, and syrup, 33,141,370 pounds; miscellaneous materials, 26,621 bushels.

Unless affected by some unforeseen disaster, the alcohol plants now established should amply supply both industrial and military needs.

AMMONIA.—Civilian uses for ammonia are principally in the manufacture of fertilizers; of ice, or as a refrigerant; in petroleum refining; in the chemical industry; in the vulcanization of rubber; in the manufacture of nitric acid and soda ash. It also enters into the production of photographic films, artificial leather, imitation ivory, dyes, rayon, lacquers, medicinal and household purposes. It is marketed in two forms—anhydrous and aqua ammonia. Military uses are principally in the production of nitric acid and its salts used in the manufacture of explosives.

The use and production of synthetic ammonia has been growing rapidly, starting with practically no production in 1921 and reaching more than 400,000 tons in 1934. World production in the same year was 3,928,248 short tons. In general, all manufacturers of chlorine can produce ammonia because they produce hydrogen as a by-product from the manufacture of chlorine.

In any major emergency, ammonia would be shipped in tank cars or converted into nitric acid at the source of production. As a result, considerable demand for tank cars and transportation would occur. Power is a factor in the production of nitrogen and hydrogen. It is impossible at this time to predict the degree of control necessary at some future period. In the event of an emergency, accurate production facilities should be secured, and if a shortage is anticipated expansion should be undertaken. Conservation could be effected by licensing the manufacturers of fertilizers, fixing quotas for each manufacturer, using synthetic nitrogen, and prohibiting its use in household refrigeration.

ASBESTOS is used as an insulating material in the construction of battleships and airplanes, as brake lining in automobiles and trucks, and for fireproofing. The main sources of imports are Rhodesia and Canada. Canada is the world's largest producer of nonspinning fiber. Domestic sources could supply but a small percentage of normal demands. Glass, wool, and vermiculite are growing in use as substitutes for asbestos in heat insulation. (*To be concluded.*)

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Month by Month

WE WELCOME JOHN DANIEL BERG AS THE newly appointed Assistant Chief of the Pittsburgh Ordnance District. He fills the important post which Col. Herbert A. Gidney held with distinction for several years.

Mr. Berg is chairman of the board of the Dravo Corporation, the great organization developed by the revered Ralph and Frank Dravo who, until their untimely deaths four years ago, were leaders in the Ordnance fraternity in Pittsburgh. Ralph Dravo, it will be remembered, was the wartime Ordnance District Chief at Pittsburgh.

The selection of Mr. Berg for this important national-defense assignment was a happy one. Not only have his industrial experience and judgment established his qualifications, but as an associate of the Dravo brothers he carries forward a cause dear to the hearts of both of them. We congratulate the Pittsburgh District on its talented acquisition and we salute the memory of two men who would approve heartily if they were here.

THE PRESENT STATUS OF TANK AND ANTI-tank is well stated by a correspondent in the last issue of *The Round Table* (British quarterly) who writes:

"The situation as regards the tank is far less clear. Here again its marked increase in speed in the postwar era has led to its divorce from its original task as an auxiliary of the infantry, and its development as an independent arm. In part, it has been transformed into a kind of armored cavalry, useful for many purposes but incapable of overcoming the resistance of a strong enemy. In part, it is designed for concentration in large bodies intended to achieve the decisive break-through in mass attack, independently of the infantry following in their wake.

"Neither of these two main forms of modern tank tactics has been tried out on a sufficiently large scale either in Spain or in China to allow a verdict yet to be given. But although the concentration of tanks into independent mass attacks certainly seems the most rational form of their employment, allowing them the full use of their main asset, mobility, the prospects for their success are today more doubtful than ever. This dubiety arises not only from their fundamental defects, which have been once more demonstrated in contemporary conflicts, but above all from the immensely increased strength of the defense. The latter comprises today a whole system, from the antitank rifles and machine guns of the infantry—to which the flamethrower appears as a most important complement—to the medium and heavy antitank guns, tank destroyers, tank mines and so on.

"This immensely enlarged strength and systematization of the defense have already had the most important effect of complicating tank attacks to an almost fatal degree. A modern tank mass attack, as it is envisaged in the service journals, presents an absolutely bewildering picture. The most complex coöperation is expected of a whole series of different arms, all and each deemed indispensable for its success: tanks for the attack, lighter tanks for dispatch service, heavier tanks for close-range artillery support, special pioneer tanks, specially trained pioneer units, rifle units on motorcycles, airplanes for reconnaissance before the attack, attack aviation for coöperating with the tanks during the attack, mobile antitank guns to protect the ground gained from tank counterattacks, heavy artillery of every caliber for the support of the attack, and, last but not least, infantry with all its own special arms and services to carry through the fundamental advance behind the actual tank attack."

Many dreams of the tank seem to have vanished into thin air; *the quick decisive thrust* seems to recede into the background. However, the necessity for protecting the soldier from the terrific hail of bullets on the battlefield remains as urgent as ever—perhaps more urgent. This, of course, was the basic idea in the conception of the tank.

Our own Army in the postwar years went through a period of speed-madness and seemed willing to sacrifice everything to speed. Modern experience seems to show that the speed enthusiasts were quite wrong. Perhaps common sense will come into its own again. The tank is a very useful weapon for definite functions, but those functions do not include climbing trees, bowling over stone walls or dropping off precipices—to what military purpose God alone knows. Tank development must continue decisively to meet two great functions which particularly fall upon such a weapon: (1) for close-in fighting in densely populated areas and (2) in open battle for a quick decisive surprise flank movement while artillery holds the front—very much as a champion fighter guards with his right and slips around a powerful body blow with his left. And for the break-through? The chances are slim!

THE NEWLY PROVIDED REGULAR ARMY RE-serve should be a big step in the direction of adequate, trained military man power. Everybody should know about it and lend a hand to help it succeed whenever occasion offers.

The Regular Army Reserve is intended to provide im-

mediate reënforcement for the Regular Army in the event of an emergency. Its membership consists of trained soldiers who, as enlisted men of the Regular Army, have been honorably discharged after at least one year of continuous service. Enlistment in the Reserve is for four years. Applicants must be physically qualified, under 36 years of age and unmarried at the time of enlistment or reënlistment in the Reserve. There is an enlistment allowance of two dollars a month payable every four months; when ordered to and accepted for active duty, there is an allowance of $3 a month for each month the Reservist has been a member of the Reserve, but not to exceed a total of $150. While on active duty the Reservist receives only the full pay and allowances of a soldier of the Regular Army of like grade and length of active-duty service.

Members of the Reserve may be discharged prior to the expiration of the 4-year enlistment (1) by direction of the President or (2) by direction of the corps-area commander (a) to accept a commission in the Regular Army, Navy, Marine Corps, Coast Guard, Officers' Reserve Corps, or National Guard; (b) to reënlist in the Regular Army, Navy, Marine Corps, or Coast Guard; (c) for physical disqualification; (d) for contemplated absence from the United States or its possessions for a period of four months or more; (e) because of sentence of imprisonment by a civil court; (f) upon evidence satisfactory to the corps-area commander of habits or traits which render his retention in the Reserve undesirable. Reservists who marry will not be reënlisted. While on an inactive status, Reservists have all the rights and privileges of any civilian, but the Government will not be responsible for hospitalization or medical care of a Reservist in an inactive status. Our National Defense Act always has provided for an enlisted Reserve, and the present legislation is the first concrete step toward actual provision of this strength. It is to be hoped that enlistments in the Reserve will be one hundred per cent of all eligibles.

THE MUNITIONS CONTROL BOARD DESERVES renewed congratulation for the prompt and satisfactory clarification of its monthly statements in respect of exports of arms, ammunition, and implements of war. In the July-August issue of ARMY ORDNANCE we called attention to the ease with which the board's published figures could be misinterpreted to mean actual shipments, whereas the figures applied only to licenses to ship. The monthly report issued by the board July 21, 1938, covering transactions for the month of June, established a new procedure in that it revealed the *actual exports* as well as the *licenses issued*. Once again the board has shown good judgment in the conduct of its official duties. It is to be regretted that the board's view on the export of helium to Germany has not prevailed!

If our present brand of "neutrality legislation" with its munitions-control provisions is to be thrown out—as it should be—or, better stated, if the Neutrality Act is scrapped before it gets us into somebody else's war—munitions control by separate and more comprehensive legislation ought to stay. In this statement we do not speak for a single producer of arms, ammunition, or implements of war anywhere. We imagine the members of the group will agree.

But two major changes in the present law would be helpful. (The word "helpful"—be it said to forestall Red agitators who continue to undermine our security by their munitions twaddle—means helpful to the national defense of the United States and nothing less.) The first change would confine the board's jurisdiction to arms and ammunition and leave out the "implements of war." Implements of war are literally everything a fighting force uses—can openers, mules, box cars, garters, rope, etc., etc. Strictly speaking, there is only one object in the vast catalogue of raw materials and manufactured products available the world over which cannot be called an "implement of war." That object is an umbrella—a soldier has no earthly, or heavenly, use for one! But raincoats and boots and rubber shoes are implements of war by strict definition if not by Presidential proclamation. If in doubt, consult the record and see how much *shoes* had to do with the Battle of Gettysburg. The inclusion of civil aircraft and parts thereof in the present list is apparently on the theory that such craft can be converted to military uses. But so can automobiles and stepladders and locomotives and brickbats and everything—except umbrellas.

Another exemplary change in the law would provide that licenses be issued to manufacturers or their agents only, and preferably to manufacturers who are coöperating with the industrial-mobilization plans of the War and Navy Departments. Such changes as these would strengthen our own national-defense position, and that is the only reason why the whole subject of the control of arms exports is worth writing about.

THE RECENT ANNOUNCEMENT FROM ENGland that Col. Sir Maurice P. A. Hankey has retired from the secretaryship of the Cabinet and of the Committee of Imperial Defense brings to a close a long period of service to the national defense of Great Britain. Sir Maurice as a civil servant had been connected with the defense services for more than forty years. His reputation for discretion is a byword in England, and while he has had an important part in shaping England's defense policy on many fronts, we mention two incidents which connect him with most important decisions of policy.

It was Maj. Gen. Sir Ernest Swinton who, on October 20, 1914, presented to Sir Maurice the idea for the development of the tank—the Holt tractor was to be developed into a trench-crossing machine-gun destroyer armed with one or more small quick-firing guns. Sir Maurice presented the idea to Lord Kitchener with barren results. He also presented it to the Committee for Imperial Defense where Mr. Churchill, a member, formed a committee at the Admiralty to investigate the idea. This became known as the Landships Committee and from it eventually came the tank.

A second and more recent incident was the testimony Sir Maurice presented three years ago before England's Royal Commission on the Private Manufacture of Arms. For all time he stated the case with thoroughness and conviction. His loss to the British Government is a real one although his counsel still will be available to it in his new capacity as a director of the Suez Canal Company.

To Teach the Modern Armorer

An Editorial

RECORD the year 1938 as marking a momentous departure in national defense theory and practice. The departure, if permanent, connotes the acceptance of a new principle in preparedness philosophy—the principle of teaching private industry how to make modern armament!

If one consults the history of national defense from the very beginning, he will find in every peaceful decade ample evidence of the need for the armorer and his craft. Thutmose III, of ancient Egypt in the fifteenth century B.C. found it so in the midst of his great test of military strength with the Hyksos at Megiddo, the first recorded battle. General Pershing found it so three thousand four hundred and seventeen years later. During this period, the task of the armorer has grown apace. Here in the pages of ARMY ORDNANCE for nearly twenty years we have urged, and at last a defense-minded Congress of the United States has authorized, educational orders. Now the time has come for a realistic approach to a question which before has had only theoretical discussion. How are educational orders going to work? That they must work is a certainty—but the method is all-important.

FIRST let us understand exactly what the educational-orders act provides. It is known as Public No. 639 of the Seventy-fifth Congress and is engrossed in Chapter 458 of the Laws of the Third Session of that Congress. Its title is "An act to provide for placing educational orders to familiarize private manufacturing establishments with the production of munitions of war of special or technical design, noncommercial in character." The complete wording of the act as approved June 16, 1938 is as follows:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Secretary of War is hereby authorized to place educational orders for munitions of war of special or technical design, or both, noncommercial in character (hereinafter called "special munitions"), and essential accessories and parts thereof needed in the military service, with commercial concerns to familiarize commercial and manufacturing establishments with the manufacture of such munitions and such accessories and parts. In arranging for placing such educational orders, bids shall be solicited only from such establishments as, in the Secretary's judgment, will be competent in time of war to manufacture the particular class of special munitions with respect to which the bid is solicited. In the determination of which classes of special munitions are to be manufactured under this act, and in the determination of which of the solicited bidders is to be awarded any contract, the Secretary shall have regard solely to the selection of such classes of special munitions and of such bidders as will, in his judgment, under all the circumstances, best serve the interest of the United States and best promote the cause of national defense. The Secretary of War shall enter into no contract under this section without the approval of the President.
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> SEC. 2. That the first of any such educational orders placed with any person, firm, or corporation for supplying any such munitions, accessories, or parts, may include a complete set of such gages, dies, jigs, tools, fixtures, and other special aids and appliances, including drawings thereof, as may be required for the production of such munitions, accessories, and parts in quantity in the event of an emergency. The title to all such facilities shall remain in the Government of the United States.
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> SEC. 3. That not more than one such educational order for the manufacture of the same, or substantially the same, article of special munitions shall be given to the same person, firm, or corporation within any period of three successive years. This section shall not prohibit the awarding of any contract during any war in which the United States is engaged.
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> SEC. 4. That, to carry out the provisions of this act, there is authorized to be appropriated the sum of $2,000,000 during each of the five fiscal years beginning with the fiscal year during which this act is enacted.

Funds for educational orders for the fiscal year 1939 are not specifically appropriated; they are authorized to be transferred from the regular military appropriation. The legislation for this is contained in the Deficiency Appropriation Act (Public No. 723—Seventy-fifth Congress, approved June 25, 1938) which contains this paragraph under the heading "Military Activities, War Department":

> Educational orders: For placing educational orders to familiarize private manufacturing establishments with the production of munitions of war of special or technical design, noncommercial in character, as authorized by law, fiscal year 1939, a sum or sums not exceeding a total of $2,000,000 may be transferred from appropriations available for other military activities for fiscal year 1939 and not required for such activities and may be utilized for the purposes of this paragraph.

THE salient features of an educational order are apparent. The thing to be produced should be essential to the military service, it should be standard and not experimental design. It must be noncommercial in character. By the latter is meant a type of equipment used so exclusively for military purposes that familiarity with the method of its manufacture would be difficult to get except through a production order from the War Department. Furthermore, the quantity of the thing to be produced will not be large and yet not small. That is to say, it should be sufficient to warrant studies looking to the development of mass-production methods. Finally, the nature of the thing to be produced should be such that a private producer could not, in time of war, meet the desired production schedules within a reasonable time from the placing of a war-time order—say for six months.

Now that educational orders are about to materialize, neither the War Department nor industry should be unmindful of the real results that are to be expected from them. The most significant part of the new legislation is that for the first time under our system of government an executive department in the normal course of events is permitted to select bidders and to award educational orders without regard to low bid. This is an extraordinary departure warranted only by the extraordinary nature of the American munitions problem. This step indicates once and for all—crack-brained pacifists to the contrary notwithstanding—that whether we can defend America or not depends upon whether we can make noncommercial military equipment in time of war in sufficient quantity and accurate quality.

The worst thing that can happen in the administration of educational orders would be fear on the part of administrative officials to face this noncompetitive issue squarely. It has been contended from the very start of the educational-orders idea nearly twenty years ago that if low bid is to govern, "education" must go by the board. The contention is sound. As we read the act we are convinced that its framers meant it to be an educational program and nothing less. Thus the Secretary of War is enjoined when awarding an educational order to "have regard solely to the selection

of such classes of special munitions and of such bidders as will, in his judgment, under all the circumstances, best serve the interest of the United States and best promote the cause of national defense." And there is a further guaranty that the educational—and not the cost—feature must be paramount, because the final authority in the award, under the act, is the President of the United States himself.

THE second section of the act brings up the all-important curriculum in the education of the modern armorer. The text of the act indicates that the first educational order to be awarded to any one firm may include the necessary gages, dies, jigs, tools, fixtures, other special appliances and drawings thereof as may be required. The title to all such facilities shall remain in the Government. This, we assume, will result in an accurate production study which will show the procedure to be followed and the difficulties anticipated in accomplishing the production schedules desired and the methods of meeting those difficulties.

Such production schedules for any given item and any one educational order may well include such subjects as these: (1) A plan for the conversion of plant or new construction if necessary to get into production; (2) An itemized list of the new machine tools required, both standard and special, together with other necessary important equipment, showing preferred and alternate sources of supply; (3) An itemized list of manufacturing accessories such as dies, jigs, fixtures, and manufacturing gages; (4) Schedules of components or accessories to be supplied from sources other than the prime contractor and of work to be performed by subcontract together with preferred sources of such materials or services; (5) Bills of materials together with preferred sources of supply, especially of those materials the procurement of which is difficult; (6) Lists of skilled personnel necessary to furnish the required man hours at the required rate; (7) An estimate of the cost to manufacture the item in quantity under the method proposed.

With these preliminary studies completed, the educational order enters its final stage when the contractor manufactures a sufficient quantity by the method and with the equipment above provided to insure that the purposes of the educational order have been accomplished. And after all this will come the period for considering an equitable contract for war-time use which would (1) assure early production, (2) contain an incentive for the reduction of cost, (3) be fair to Government and contractor alike, and (4) guarantee an ordinate—and prohibit an inordinate—financial return.

On this latter point—financial return—every proponent of educational orders from the first has conceded the nonprofit nature of these peace-time training courses. But, as educational orders have a nonprofit nature so also have they a nonloss nature—the contractor will not make money on his armament education but neither can he be allowed to lose money. The administration of this feature will demand fairness and common sense on both sides of the table at which the negotiators for Government and industry sit. But on this point there is a tradition of long standing—American industry has not failed in its coöperation with the national defense, and nowhere should that truth be better known than in the Army and Navy of the United States.

Thus it would appear that educational orders at the moment present two problems: The first is a problem of the War Department itself, the second a problem of industry. The War Department's problem is to decide—on a purely objective basis without regard whatsoever to any consideration other than military necessity and based exclusively on professional military judgment—the nature and the kind and the number of the special munitions which are to be manufactured under the act. These are obviously by no means restricted to ordnance. They include also matériel procured by the Air Corps, the Signal Corps, the Corps of Engineers, the Medical Department, the Quartermaster Corps and the Chemical Warfare Service. How lengthy the catalogue of "special munitions" will be is the question to be determined—but the list need not be great.

Here then, must priority be established. Professional military judgment must determine which items come first and, having decided, that judgment must be final. But it also must determine that such orders as it is able to place with the limited funds at its disposal *are educational* and educational without regard to low bid.

INDUSTRY'S problem is equally difficult. As educational orders are not a source of profit, industry may not be anxious to have them in times of good business and may seek to hold them in reserve for "hard times." Should this be so, the situation will be as critical as it would be if the War Department awarded educational orders on the basis of price. It is, of course, only good common sense to assume that such educational orders as are awarded will go to those companies which have coöperated in the War Department's procurement-planning activities, whose stability is known, whose permanency is established, and whose loyalty to the national defense is unquestioned. But many of our critical items of munitions are most expensive. Two million dollars a year for five years spread over the needs of six great supply services of the Army is very meager. The War Department's studies of its needs to meet the current authorization should be an excellent basis on which the Congress could authorize educational grants in order that the subject matter of the education may include more courses and the student body be increased in size. The present authorization is a good start.

We hope that the policies finally determined upon by the War Department will be given the utmost publicity in order that all who have energetically sponsored this program for so many years may be kept familiar with its progress, and further, that private industry may know and understand the limitations which are still very real in the educational-orders program. An authorization of $2,000,000 a year for five years is scarcely sufficient to scratch the surface of this great educational program; $50,000,000 during five years would be more nearly adequate, and even then much education of many pupils would be impossible. But if the War Department, understanding its problem, will face it fearlessly, and if industry, knowing its responsibility, will be patient and abide by professional judgment, then even this meager beginning of educational orders is fraught with tremendous potentialities. For it may be that the first student contractor selected for a course in the production of modern armor may be the reserve of knowledge and experience in time of war to swing the tide of battle.

Association Affairs

ELECTION OF OFFICERS

THE biennial election of officers and three national directors of the Association for terms beginning January 1, 1939, will be held by letter ballot in accordance with the provisions of the Association's constitution on Tuesday, September 6, 1938. Ballots have been forwarded to all members who are entitled to vote. Polls will close at 12 o'clock noon on the above date.

The nominees selected by the Comittee on Nominations are: For officers to serve two years: for president—Brig. Gen. Benedict Crowell of Cleveland, Ohio; for vice-presidents—Col. William W. Coleman of Milwaukee, Wis., and Col. Frederick H. Payne of Greenfield, Mass.; for directors (to serve four years): Maj. Gen. C. C. Williams of South Hamilton, Mass.; Brig. Gen. Samuel McRoberts of New York, N. Y., and Lieut. Col. LeRoy Hodges of Richmond, Va.

The Committee on Nominations consisted of the following members: Col. H. A. Gidney, representing the Pittsburgh Post, chairman; W. W. Tangeman, representing the Cincinnati Post; Earl B. Gilmore, representing the Los Angeles Post; Col. Henry P. Erwin, representing the Washington Post, and Col. C. S. Robinson representing the Boston Post. Below are presented brief introductions of the respective nominees:

BRIG. GEN. BENEDICT CROWELL, Inactive Reserve, was the Assistant Secretary of War and Director of Munitions during the World War. He was one of the founders of the Army Ordnance Association and its first and only president. His service has continued uninterruptedly since October 1, 1919.

General Crowell received his early education at St. Paul's School, Concord, N. H., and was graduated from Yale University from which he also received an honorary degree in 1918. By profession a mining engineer, General Crowell's first service to the national defense was his assistance to the General Munitions Board in 1917 in its important analysis of steel production in the United States. He was a member of the Kernan Board which, under the National Defense Act of 1916, conducted an investigation of the "feasibility, desirability and practicability of Government manufacture of arms, munitions and equipment." He was commissioned a major in the Reserve Corps and placed in charge of the Washington office of the Panama Canal where he served until his resignation to accept appointment as the Assistant Secretary of War in November 1917.

As Director of Munitions, General Crowell was responsible for the purchase of arms and equipment for our military forces, and his conduct of this great responsibility in one of the highest administrative positions in the United States during the World War won for him respect and admiration. The record of his service is told in an official report submitted after the termination of the war, "America's Munitions 1917-1918," and in the 6-volume work "How America Went to War" (prepared in collaboration with Capt. Robert Forrest Wilson). He is the coauthor (with Charles B. Murray) of "Iron Ores of Lake Superior." He was commissioned a brigadier general in the Ordnance Reserve in 1931. He is president of the Central National Bank of Cleveland, Ohio.

COL. WILLIAM W. COLEMAN of Milwaukee, Wis., was a special assistant to the Chief of Ordnance, U. S. Army, in charge of the vast artillery production program during the World War. He was commissioned a colonel in the Reserve Corps. A native of Maryland, Colonel Coleman was graduated from Lehigh University and began his metallurgical engineering practice with the Bethlehem Steel Company, later being associated with the Crucible Steel Company and Latrobe Steel and Coupler Company. His long service with the Bucyrus Company, manufacturers of machinery, began in 1905. He became president of the company in 1911 and later of its successor, the Bucyrus-Erie Company of South Milwaukee. He is a director of the Marshall and Ilsley Bank, the Milwaukee Electric Light and Railway Company, Nordberg Manufacturing Company, the American Brake Shoe and Foundry Company, Oil Gear Company, and a trustee of the Northwestern Mutual Life Insurance Company. He has served as a vice-president of the Association since 1919 and as president of its Milwaukee Post since 1928.

COL. FREDERICK H. PAYNE, Ordnance Reserve, was the Assistant Secretary of War in the administration of President Hoover from 1930 to 1933. Commissioned a major in the Ordnance Department in 1918, he was procurement officer of the Bridgeport Ordnance District, and of the Bridgeport District Claims Board. In the postwar organization of the Bridgeport District, Colonel Payne became assistant chief, serving continuously from 1919 to 1930. He resumed these duties at the termination of his service as the Assistant Secretary of War in 1933.

Colonel Payne was born in Greenfield, Mass., and received his education in the schools of that city. He became a state bank examiner in 1906. He was president of the Mechanics Trust Company, Boston, and later vice-president of the Federal Trust Company. He was successively treasurer, vice-president, president, and chairman of the board of the Greenfield Tap and Die Corporation from 1912 to 1930, during which period he was for a time a partner of Tucker Anthony and Company, investment bankers of New York and Boston. He is now president of the Greenfield Tap and Die Corporation. He has served as a vice-president of the Army Ordnance Association since 1937 when he succeeded the late Col. William C. Spruance.

MAJ. GEN. C. C. WILLIAMS was Chief of Ordnance during the World War and for twelve years thereafter until his retirement from active military service. He was graduated from the U. S. Military Academy in 1894. In 1898 he joined the famous Astor Battery and saw service as an officer of the Field Artillery in the Philippines. He held many offices of responsibility in the Ordnance Department, at the various arsenals and as inspector of ordnance matériel until 1916 when he was department Ordnance officer at the time of General Pershing's Punitive Expedition into Mexico. He was a member of the first contingent of officers who sailed with General Pershing on the S.S. BALTIC for France, May 28, 1917. He was Chief Ordnance Officer of the A.E.F. from June 1917 to April 1918 when he returned to the United States to become Chief of Ordnance of the Army. His service thereafter is the record of American ordnance during the remaining months of the World War and the twelve crucial years of the postwar period. The Williams Medal for Distinguished Ordnance Service was founded by the Army Ordnance Association in his honor and awarded to him October 8, 1930. He has served as a director of the Association since 1931.

BRIG. GEN. SAMUEL McROBERTS was chief of the Procurement Division, Office of the Chief of Ordnance, during the World War prior to his service in France. He is chief of the New York Ordnance District and president of the New York Post of the Association.

General McRoberts was born in Missouri and was graduated

from Baker University, Baldwin, Kans. He completed his course in law at University of Michigan in 1893 and became connected with the legal department of Armour and Company. In 1909 he became vice-president of the National City Bank of New York. He is a director in many financial and industrial organizations.

He was commissioned a major in the Ordnance Reserve Corps in November 1917 and directed the huge purchasing program of the Department as chief of its Procurement Division. In August 1918 he was appointed a brigadier general and transferred to the A.E.F. He has served as a director of the Army Ordnance Association since 1919.

LIEUT. COL. LeROY HODGES is Comptroller of the Commonwealth of Virginia and State Ordnance Officer of the Virginia National Guard. He is the author of "Postwar Ordnance" (1923).

Colonel Hodges, a native of North Carolina, has been identified with the civic and economic development of the South and particularly of the State of Virginia for many years. Educated at Washington and Lee University, he specialized in the fields of immigration and applied economics in this country and abroad. As managing director of the Virginia State Chamber of Commerce he took an important part in the development of the industrial and cultural resources of Virginia. He was chairman of the Association's membership committee for several years and an active leader in the furtherance of educational orders for the peace-time manufacture of ordnance. He has served as a director since 1935 when he succeeded the late Pliny E. Holt.

NEW MEMBERS

DURING the period May 19 to July 31, 1938, inclusive, the following applicants were admitted to membership in the Army Ordnance Association: Milton M. Adler, Newark, N. J.; Erik Aldeborgh, Poughkeepsie, N. Y.; John L. Alden, Maplewood, N. J.; F. W. Altorfer, New York, N. Y.; George Emmanuel Alves, Hayward, Calif.; Walter C. Alvin, Chicago, Ill.; H. D. Anderson, Midland, Mich.; J. A. Arter, Milwaukee, Wis.; Hinckley G. Atwood, Chicago, Ill.; William M. Austin, Yonkers, N. Y.

Eugene G. Bailey, New York, N. Y.; B. E. Bassett, East Alton, Ill.; John L. Batchelder, Boston, Mass.; Robert E. Battles, San Marino, Calif.; H. C. Bayliss, Detroit, Mich.; Clyde D. Berger, Gettysburg, Pa.; Ernst Berl, Pittsburgh, Pa.; George Birkenstein, Chicago, Ill.; Ralph E. Bitner, Port Washington, N. Y.; Geert Blaauw, Port Chester, N. Y.; Donald M. Blake, Jackson, Ohio; August H. Blohm, Oak Park, Ill.; Charles P. Bobe, St. Louis, Mo.; A. N. Bradford, Sterling, Ill.; Ralph N. Brescia, Bronx, N. Y.; Ira L. Bretzfelder, St. Louis, Mo.; Frank J. Bristol, Ithaca, N. Y.; D. A. Brophy, Elgin, Ill.; Daniel A. Brown, Jr., Chicago, Ill.; Nelson T. Brown, Philadelphia, Pa.; Ralph W. Brown, Bridgeville, Pa.; Richard E. Brown, New York, N. Y.; Theophilus Brown, Moline, Ill.; William L. Bryan, St. Louis, Mo.; Burt S. Burke, St. Louis, Mo.; Edward J. Burnell, Chicago, Ill.; Helmut W. Buse, Lorain, Ohio.

John Calahan, Jersey City, N. J.; Emile M. Chamot, Ithaca, N. Y.; Jesse H. Choguill, Syracuse, N. Y.; William M. Choguill, Syracuse, N. Y.; Edgar W. Clarke, Cambridge, Mass.; James A. Conklin, Ramsey, N. J.; William D. Cook, Marysville, Calif.; B. W. Cooke, Glencoe, Ill.; L. B. Coon, North Plainfield, N. J.; B. H. Cooper, Red Wing, Minn.; Kern H. Copeland, Los Angeles, Calif.; J. D. Coughlan, Fort Shafter, T. H.

John J. Daly, Newark, N. J.; G. L. L. Davis, St. Louis, Mo.; William Debenham, Louisville, Ky.; E. W. Dickett, Rockford, Ill.; Earl E. Diehl, Clayton, Mo.; G. K. Dreher, Milwaukee, Wis.; Robert O. Driver, West Orange, N. J.; W. W. Edens, Wauwatosa, Wis.; E. B. English, Peoria, Ill.; Philip Ferber, North Haledon, N. J.; Alexander D. Ferguson, Michigan City, Ind.; E. F. FitzSimmons, Bridgeville, Pa.; P. E. Floyd, Chicago, Ill.; Edward D. Frank, Cincinnati, Ohio; Oscar Frohman, Milwaukee, Wis.; Julius F. Funk, Chicago, Ill.

W. R. Gotley, Pueblo, Colo.; G. R. Greenslade, Bridgeville, Pa.; Robert E. Grote, St. Louis, Mo.; Allen Guiberson, Dallas, Tex.; Robert C. Gunther, Chicago, Ill.; John L. Hasemann, West Caldwell, N. J.; John H. Hauberg, Rock Island, Ill.; James G. Haworth, Toledo, Ohio; Herman C. Heink, Clayton, Mo.; J. C. Heitman, Fanwood, N. J.; Robert F. Herrick, Boston, Mass.; John B. Howard, Marblehead Neck, Mass.; Max H. Hurd, Chicago, Ill.; Martin H. Jenkins, Benicia, Calif.; Stephen M. Jenke, Gary, Ind.; Walter F. Johnson, San Francisco, Calif.; David T. Jones, Los Angeles, Calif.

William Kelly, Buffalo, N. Y.; Peter Keupp, West New York, N. J.; W. T. Kilborn, Bridgeville, Pa.; P. A. Knudsen, Milwaukee, Wis.; F. K. Landgraf, Bridgeville, Pa.; S. C. Lawson, Milwaukee, Wis.; Harry R. Leonard, El Monte, Calif.; Orel E. Lewis, Fort Jones, Calif.; R. E. Locher, Milwaukee, Wis.; Walter L. Loegler, Chicago, Ill.; Martin J. Luther, Chicago, Ill.; Walt Marsh, Belleville, Ill.; L. H. Martin, Waynesboro, Pa.; W. C. Masters, Bridgeville, Pa.; William L. Maxson, New York, N. Y.; J Kenneth McBain, Chicago, Ill.; Joseph F. McCarthy, East Hartford, Conn.; J. A. Merquelin, Midland Park, N. J.; C. R. Messinger, Milwaukee, Wis.; G. R. Meyercord, Jr., Chicago, Ill.; John F. Mitchell, Worcester, Mass.; Edward Montague, Chicago, Ill.; James Edw. Murphy, Knoxville, Tenn.; Philip G. Murphy, Chicago, Ill.; Alfred W. Navel, St. Louis, Mo.; M. Newcomer, East Alton, Ill.; William S. Newell, Bath, Maine; Dan Nuckolls, Jr., Glendale, Calif.; John J. O'Fallon, St. Louis, Mo.; L. A. Paradise, Moline, Ill.; W. B. Peirce, Bridgeville, Pa.; Ralph Peterson, Roslindale, Mass.; Harold F. Pitcairn, Philadelphia, Pa.; Paul Poock, Dayton, Ohio; Joseph M. Price, New York, N. Y.; William J. Priestley, New York, N. Y.

L. R. Rathmann, Elgin, Ill.; Clarence W. Robertshaw, Greensburg, Pa.; Oscar C. Roesen, New York, N. Y.; Andrew W. Roth, St. Louis, Mo.; John Sanderson, New York, N. Y.; Leo Schultheis, Brooklyn, N. Y.; George E. Scott, Chicago, Ill.; D. A. Shaw, Bridgeville, Pa.; Charles N. Stone, Moline, Ill.; Severre Skagen, E. E. Pittsburgh, Pa.; Erwin P. Stupp, St. Louis, Mo.; Harry F. Suiter, Rahway, N. J.; Herbert E. Tautz, Milwaukee, Wis.; Joseph J. Thomason, Webster Groves, Mo.; John P. Tierney, Boston, Mass.; Paul L. Tollison, Plainfield, N. J.; J. H. Truschel, Bridgeville, Pa.; R. M. Tussing, York, Pa.

Ray W. Uecker, Milwaukee, Wis.; Lee D. Van Antwerp, Meriden, Conn.; A. E. Van Cleve, South Orange, N. J.; J. N. Van Patten, Davenport, Iowa; William M. Vermilye, Plainfield, N. J.; William J. Waters, Elizabeth, N. J.; Arthur R. Weckel, Brooklyn, N. Y.; R. O. F. Wettergren, Brooklyn, N. Y.; J. Van H. Whipple, Brooklyn, N. Y.; C. Harold White, Moline, Ill.; W. M. Wilson, Chicago, Ill.; Frank C. Wright, New York, N. Y.; Lucien I. Yeomans, Chicago, Ill.; E. X. Xander, Moline, Ill.; C. J. Zaiser, Wauwatosa, Wis.; J. D. Zaiser, Wauwatosa, Wis.; Walter B. Zietz, Moline, Ill.

NECROLOGY

EDWARD OTIS GOSS, president of the Scovill Manufacturing Company and a charter member of the Army Ordnance Association, died at his home at Waterbury, Conn., July 4, 1938 in his seventy-third year. Individually and as an official of the company, Mr. Goss rendered patriotic service to his country during the World War. The Scovill organization was one of the leading producers of equipment to meet the huge ordnance program of the United States Army during that conflict.

Mr. Goss was born in Waterbury in 1865 and was graduated from the Massachusetts Institute of Technology in 1887. He joined the Scovill Company as a draftsman the following year. Ten years later he was made a director of the company and in 1900 became assistant treasurer. He was general manager of the Scovill organization during the World War and administered his great responsibilities with distinction to the service of the Allies and later the United States. He had been president of the company since 1920.

He was chairman of the board of the Citizens and Manufacturers National Bank of Waterbury, a director of the New York, New Haven and Hartford Railroad, the Connecticut Company, and Landers, Frary & Clark. Always active in civic affairs, he was a former member of the Board of Aldermen, a member of the Board of Public Works, and of the Board of Education of Waterbury. He was also a fellow of the Royal Society of Arts of London and a member of the American Society of Mechanical Engineers.

A leader in the industrial activities of New England, Mr. Goss was most interested in the Hartford Ordnance District in its peace-time procurement-planning activities.

ARTHUR ANDRUS COBURN, a charter member of the Army Ordnance Association, died May 11, 1938, after approximately thirty-five years of service in the Ordnance Department. During his earlier service, Mr. Coburn was employed as computer on gun carriages. In his later years he was Assistant Chief Engineer of the Artillery Division, Manufacturing Service, Office of the Chief of Ordnance and was responsible for the development and maintenance of the drawing standards of the Ordnance Department. He represented the War Department on the American Standards Association Committee on Drafting Room Practice and acted on other committees having to do with standards.

Mr. Coburn was one of those few civilians whose long experience and historical knowledge of past practice is of inestimable value in conducting the work of the Department. His death is a great loss to both the Ordnance Department and the Association for his ability and loyalty were of the highest order and both were of the kind which is difficult to replace. D. A. G.

LIEUT. COL. FREDERICK A. LORENZ, JR., a former director of the Chicago Post, Army Ordnance Association, and a vice-president of the American Steel Foundry Company, died July 23, 1938, at Chicago in his fifty-second year. He was born in Lansing, Mich., and studied at University of Chicago and University of Illinois from which he was graduated in 1909. First in the employ of the Chicago and Northwestern Railroad as an inspection engineer, and later as superintendent of the East Chicago Railway Mill of the Republic Steel Company, Colonel Lorenz joined the American Steel Foundry Company, advancing to a vice-presidency.

Well known as a speaker and writer on engineering subjects, he had been president of the Steel Foundries Society of America for five years and a director of the American Foundrymen's Association.

As an officer of the Ordnance Reserve, Colonel Lorenz was assigned to the Chicago Ordnance District. He served as a director of the Chicago Post, Army Ordnance Association for several terms.

Notice also has been received of the death of the following members of the Association: Jeremiah Beall, New York, N. Y.; H. A. Gillis, Washington, D. C.; H. H. Linn, Morris, N. Y.; John W. Marder, Rochester, N. Y.; John W. Prentiss, New York, N. Y.; Samuel L. Shober, Philadelphia, Pa., and G. S. Wheat, New York, N. Y. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association, extends condolences.

Ordnance Gazette

THE following is the list of officers of the Ordnance Department of the Army, with their stations. Customary changes at this season of the year make it difficult to keep currently informed about friends and acquaintances in the Regular service, so the list is published for the information of members of the Army Ordnance Association.

Adamson, Keith F., Lieut. Col., Aberdeen Proving Ground, Md.
Allen, Charles K., 1st Lieut., Watertown Arsenal, Watertown, Mass.
Aman, Joseph L., Maj., Aberdeen Proving Ground, Md.
Armitage, John D., 1st Lieut., Aberdeen Proving Ground, Md.
Armstrong, Donald, Lieut. Col., Office of the Chief of Ordnance, Washington, D. C.
Atwood, Frank J., Maj., Fort Knox, Ky.
Aurand, Henry S., Lieut. Col., Picatinny Arsenal, Dover, N. J.
Baird, Arthur R., Maj., Hq. Ninth Corps Area, Presidio of San Francisco, Calif.
Baker, James O., 1st Lieut., Aberdeen Proving Ground, Md.
Bandholtz, Cleveland H., Lieut. Col., Office of the Chief of Ordnance, Washington, D. C.
Barclay, John A., Jr., 1st Lieut., Aberdeen Proving Ground, Md.
Bardsley, George H., Capt., Birmingham Ordnance District, 250 Federal Building, Birmingham, Ala.
Barnard, Clarence, Maj., San Antonio Arsenal, San Antonio, Tex.
Barnes, Gladeon M., Lieut. Col., Office of the Chief of Ordnance, Washington, D. C.
Barr, Robert S., Lieut. Col., Watervliet Arsenal, Watervliet, N. Y.
Barroll, Morris K., Jr., Maj., Fort Bragg, N. C.
Barry, Edwin F., Maj., Watertown Arsenal, Watertown, Mass.
Bassett, Ralph H., Capt., Hamilton Field, Calif.
Becker, Ward E., Maj., Fort Lewis, Wash.
Bell, William L., Jr., 1st Lieut., U. S. Military Academy, West Point, N. Y.
Bellinger, John B., Maj., Fort Benning, Ga.
Beyma, Severin R., 1st Lieut., Ordnance School, Watertown Arsenal, Watertown, Mass.
Billingsley, John D., Capt., Ordnance Field Service School, Raritan Arsenal, Metuchen, N. J.
Blackmore, Philip G., Lieut. Col., Cleveland Ordnance District, 1524 Keith Building, Cleveland, Ohio.
Boatwright, Walter P., Col., Frankford Arsenal, Philadelphia, Pa.
Bodeau, Edward, 1st Lieut., Ordnance School, Aberdeen Proving Ground, Md.
Bodine, Robert N., Lieut. Col., Office of the Chief of Ordnance, Washington, D. C.
Bomar, Ernest C., Maj., Frankford Arsenal, Philadelphia, Pa.
Booth, Lucian D., Col., Office of the Chief of Ordnance, Washington, D. C.
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Ordnance in Review

AN AMERICAN HERITAGE, PART IV

BY LIEUT. COL. CALVIN GODDARD, ORD. RES.

BOTH of the criticisms expressed by contemporary ordnance experts with respect to the Henry rifle appear specious, inasmuch as leading was a common fault with black-powder rifles and remains a scourge today when such powder is used as a propellant unless careful cleaning of the bore is undertaken after every few shots. And he who would expect much accuracy at 400 yards and over from a caliber .44 bullet of 216 grains driven

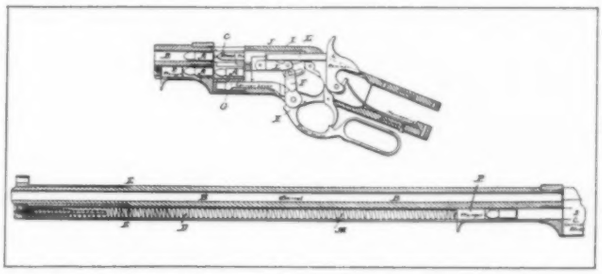

FIG. 15. THE HENRY MAGAZINE RIFLE, MODEL 1860

by 25 grains of this compound, is asking the physically impossible.

It is true that accuracy at long range *was* attainable with rifles of the fifties and sixties—as witness Whitworth's caliber .45 piece of 1857, which made creditable targets at 2000 yards. But this was a single-shot arm with a barrel of 39 inches (as against the 24-inch barrel of the Henry) and carried a bullet three diameters in length (the Henry projectile was short and stubby) with 70 grains of powder behind it. This was feasible in a muzzle-loading weapon, such as Whitworth's, but was not then practicable with the weak copper cases used in the rim-fire ammunition of the day, for which a charge of 25-30 grains often reached the upper limits of safety. And the central-fire case had not at the time received much consideration in this country. So considering the limitations imposed by its ammunition, the performance of the Henry was by no means discreditable.

At any rate, this rifle soon came to command respect among riflemen, both civil and military, and its capacious magazine, permitting a multiplicity of shots without reloading, made it extremely useful to plainsmen faced with a sudden onslaught by hostile Indians. One may imagine the discomfort of the latter, accustomed as they were to facing single-shot weapons, usually muzzle-loaders at that, when they first walked into the fire of some straight-shooting emigrants, California bound, armed with Tyler Henry's product.

FOR six years the 1860 model Henry (Fig. 15: from U. S. patent No. 30,446) remained the only type marketed by its parent company, but in 1866 this firm, now become the Winchester Repeating Arms Company with Oliver Winchester in command, brought out the first Winchester—the model 1866. The caliber of .44 rim-fire was maintained, and no new ones were added, but the arm was put out in a variety of barrel types (round, half-octagon, and octagon) as against the standard octagon barrel of its predecessor, though the length remained at 24 inches. Likewise a 20-inch round-barrel carbine was added to the line, as was a military model with full-length stock and 27-inch round

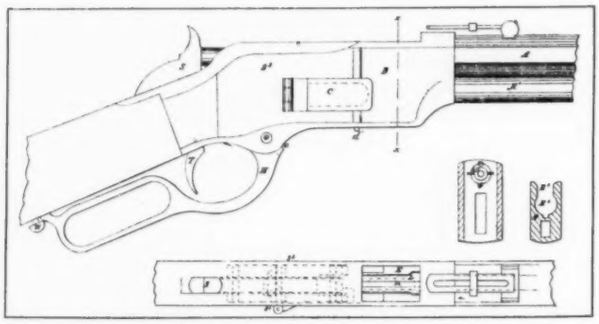

FIG. 16. THE KING MAGAZINE RIFLE, 1866

barrel. According to Satterlee ("A Catalog of Firearms for the Collector": Detroit, 1927), Turkey purchased a supply of the last-named about 1870, and is reputed to have used these with deadly effect in the Russo-Turkish War of 1877-1878, although the *Encyclopædia Britannica* indicates that her cavalry only was armed with the Winchester—and in the form of the carbine at that.

At any rate, the American-made Peabody-Martini .45 single-shot, plus the Winchester .44, proved more than equal matches for the clumsy caliber .60 Krnka, a converted muzzle-loader, and the more modern .42 Berdan with which the Russians were armed. Indeed the Winchester rendered such yeoman service in the hands of the "unspeakable Turk" at the siege of Plevna, that, according to Ommundsen and Robinson ("Rifles and Ammunition": London, 1915), "The powers who had been hesitating as to the advisability of fitting themselves out with magazine rifles immediately began to give a great deal of attention to the matter."

THE new rifle, as marketed for the first time under Winchester's name (he had been president of the predecessor companies since 1857), differed from the Henry chiefly in the manner of loading—this now being effected through a gate in the right side of the receiver under a patent issued on May 22, 1866 to one Nelson King and purchased from him by Winchester for incorporation in his improved arm (Fig. 16: from U. S. patent No. 55,012). The Henry had been loaded from the *forward* end of the magazine tube, just rearward of the muzzle, the tube being cleared of its long coiled spring to permit this by compressing the spring manually into a short sleeve at the muzzle, then rotating the latter to one side so as to free the mouth of the tube. This construction necessitated a slot running the full length of the tube to permit grasping a projection on the cartridge follower (designated "plunger" in Fig. 15) shoving the follower,

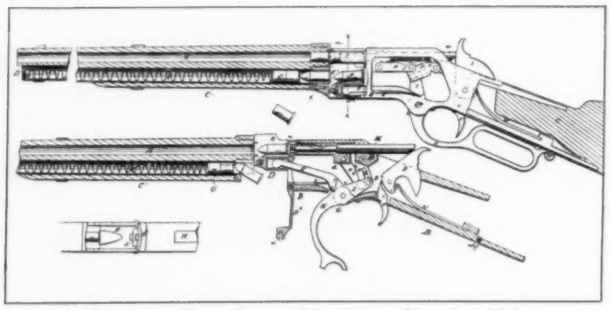

FIG. 17. THE SMITH MAGAZINE RIFLE, 1866

and with it the spring, toward the muzzle, thus effecting the necessary spring compression. But this slot constituted a serious defect in that it gave access to mud, snow, and other extraneous matter.

So King's improvement was a very real one, as it permitted the complete inclosure of spring and cartridges in a practically dustproof tube, and its sound design is attested by the fact that this device remains incorporated in almost every type of lever-action, tube-magazine weapon in use today.

That the King modification was not the only one considered by the Winchester Company is evidenced by the existence of two patents upon other designs of loading mechanisms also granted in 1866, both intended as improvements on the manner of loading employed in the original Henry. The first of these (Fig. 17: from U. S. patent No. 52,934) was issued on February 27, 1866, to one James D. Smith of New Haven, Conn., and assigned by him to Oliver Winchester. The second issued a little over six months later (September 4th), to Winchester himself (Fig. 18: from U. S. patent No. 57,808). Smith's patent involved a device for loading the magazine tube from the rear (*i. e.*, at the receiver, rather than at the muzzle), but required the disengagement of tube from receiver to accomplish this, whereas the King

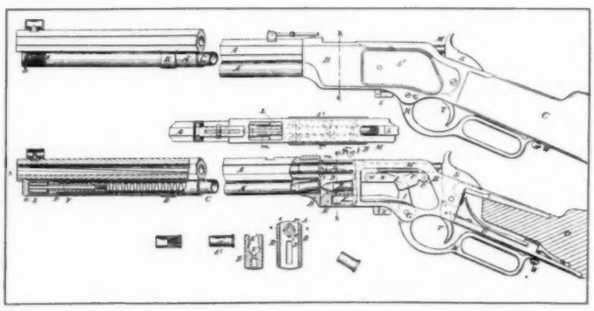

FIG. 18. THE WINCHESTER MAGAZINE RIFLE, 1866

design was preferable in that it permitted a rigid and immobile tube. Winchester's patent provided an inner magazine tube, sliding within a fixed outer one, and loading at the muzzle end. This did away with the troublesome slot, but was not as convenient as King's design when rapid reloading was necessary.

Unlike its predecessors, the new Winchester Company was located not in New Haven but at Bridgeport, Conn. It remained there until 1870 when it returned to its home city where it has been ever since. For some time after this move it continued to produce nothing save its original model of 1866. But central-fire ammunition now had been perfected, and rapidly was showing its superior possibilities as compared with its rim-fire competitors. It behooved the company to keep abreast of the times. Its answer was the model of 1873—probably the most famous rifle ever produced, regardless of time or place. (*Continued.*)

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Book Reviews

SWORD, LANCE, AND BAYONET. A RECORD OF THE ARMS OF THE BRITISH ARMY AND NAVY. By Charles ffoulkes and E. C. Hopkinson. Cambridge: The University Press; New York: The Macmillan Company. $5.00.

THE sword, the authors of "Sword, Lance, and Bayonet" say, developed from the sharpened Stone Age club in the process of experiments over thousands of years; the lance has remained the same tree sapling of antiquity with but a metal point added; and eventually the point has been taken off and attached to the firearm to form the bayonet. Of these primitive weapons the sword is acclaimed the most important; yet for centuries, it is stated, the most highly skilled craftsmen failed to produce a completely satisfactory weapon.

The authors contend that the great swords of the mounted knight, for instance, from the tenth to the fifteenth century, were lacking in every quality a sword should possess. The grips were small, the blades heavy and ill balanced, and the points of little or no use for the thrust. "Primarily, the purpose of the sword," say the authors, "is as a weapon of offense and secondarily as a guard. From the thirteenth century onward," they claim, "most types of swords failed notably in both these factors."

Here is an excellent history of the tortuous progress of standardization of personal weapons in the British service, and of the sword through the centuries. Early regulations are interestingly traced, and the various designs of swords used in the British Army by general officers, cavalry, artillery, engineers, infantry, pioneers, the band, and departmental corps, are described in detail. Swords of the Royal Navy also are discussed, and belts, slings, and sword knots are generously treated.

The story of the lance is well told, and the student of the bayonet will find much valuable information concerning its development as a weapon.

An added feature of the book is an appendix on muskets, rifles, and carbines. Well illustrated with clear plates and superb line sketches, with a bibliography and a comprehensive index, this volume makes a worth-while addition to the library of the ordnance student and collector of weapons. Its authors are recognized authorities on armor and military equipment. Dr. ffoulkes is Master of Armouries of the Tower of London and author of "The Gun Founders of England" and other works. Captain Hopkinson holds the British Military Cross for distinguished service.

LeR. H.

AUGUSTUS. By John Buchan. Boston: Houghton, Mifflin Co. $4.50.

THE stage was well set for the publication of this life of Augustus in the year 1937, the two thousandth anniversary of his birth. Moreover, those who look on the convulsions and chaos of our own time are naturally interested in a man who commenced his life work in a world similarly distraught and brought peace and discipline to a weary empire. Mr. Buchan's biography of the Roman who accomplished this miracle destroys the belief that Augustus was merely chairman of a board of skilled advisers. Augustus was the author and the builder of the Roman Empire, and to him must go the credit for its establishment. To be sure, his staff of skilled assistants was of vast significance in determining the ultimate structure of the government. But Mr. Buchan's Augustus is a man of sufficient force of character, personality, and ability to have achieved his purpose even with less effective assistants.

No man can undertake biography without an inclination to identify himself with his subject, to shoulder the responsibilities, and to perform the deeds of his protagonist. This must have been particularly true of Mr. Buchan in this work on Augustus. The present British pro-consul in Canada knows the problems of government, and he has been a soldier with a distinguished record. In short, his own life and times have fitted him to interpret the life and times of Augustus and have provided an insight into the problems of Augustus that make him a sympathetic and understanding interpreter. The biography is the fine work that could be anticipated from a writer of Mr. Buchan's ability and experience.

The interplay of personalities and events two thousand years ago, in a period of economic and political chaos, results in many pertinent admonitions for modern America. There will be yearning for the comparative happiness of Augustus in his troublesome environment for, writes Mr. Buchan, "Augustus had notable advantages. He had to deal with the stubborn reactionary, but he was little troubled by the foolish progressive. The voice of the revolutionary was stilled; Rome had had too much of him and craved about all things for order and decorum. Nor did he suffer from the minor intellectual, the man whose talent is for a cheap disintegration. Rome did not want the atomizer; her one desire was to escape from chaos."

Mr. Buchan's biography of Augustus is thorough and beautifully written. It throws a clear light on one of the most important periods of the world's annals and on one of the most important figures of human history.

D. A.

THE LOST BATTALION. By Thomas M. Johnson and Fletcher Pratt. New York: The Bobbs-Merrill Company. $3.00.

MAJOR Whittlesey's 1st Battalion of the 308th Infantry, a National Army outfit, sprang into headline news in October 1918. Participating in the Argonne drive, it became entirely separated from its supports, and held out alone until relieved five days later. Few books which pass through the hands of the reviewer move him to so mingled a feeling of rapidly alternating approval and disapproval as does this 338-page account of one of the most stirring episodes in all our military history. A score of times irritation grips him, only to be followed by renewed interest. This does not arise from any inherent weakness in the narrative itself, but from the somewhat unusual style and arrangement of the book.

Interspersed with these parts are others which are somewhat sloppy, extremely slangy, and a bit trivial. It is regrettable that the book, in these places, suffers from the incoherent and sensational flippancy of modern journalese. Why not choose your style of writing, and stick to it throughout?

Viewing the action from many different angles almost simultaneously may serve well to keep up the suspense of the reader, but makes it most difficult to convey a clear picture of the whole affair. The frequent use of German phrases, without translation, and the occasional outcropping of guttersnipe language, prove most annoying. In these respects "The Lost Battalion" definitely fails to satisfy. Yet in all fairness it should be said that the volume has its good points, and strong ones. It is very exhaustive in its factual research, and extremely just in the conclusions drawn by its authors. The treatment of the characters and actions of those involved in the episode of "The Lost Battalion," is quite satisfactory. They have plotted their course midway the extremes of hero worshipping and muckraking, and in the case of such a bitterly discussed affair, this is by no means easily done.

A foreword and a prologue precede, and a thorough account of the postwar repercussions of the affair, follows the main narrative. There is a useful index, and the book is illustrated by six relief maps and eight photographs. Use is made of two somewhat novel and interesting devices to add to the reader's understanding—a thumb-nail sketch of the characters, and an account of the fortunes of many of the battalion's survivors.

F. W. F. G.

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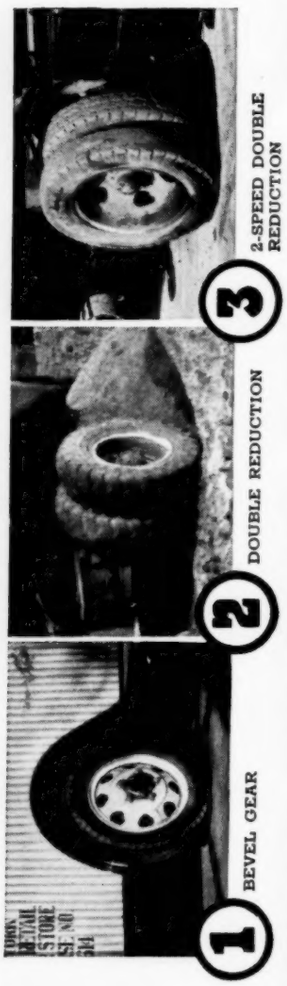

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COMPLETE GUIDE TO HANDLOADING. By Philip B. Sharpe. New York: Funk & Wagnalls. $7.00.

THIS is the first book to be published in a number of years on the subject of handloading ammunition, and with the rapid advance that has taken place during this interim it can be said to contain more information than any other previous volume. It is true that various manufacturers of tools and component equipment periodically have issued small handbooks giving the principles of handloading for the types of tools they manufacture. These are indeed a most worthy addition to any handloader's library. However, unless one constantly reads and carefully files the data which appear from time to time in the various sporting magazines, up-to-date information is difficult to find. Now Mr. Sharpe has placed at the disposal of the handloader and the shooter in a single volume up-to-the-minute information pertaining to handloading either used cartridge cases or new components.

The author is Firearms Editor of *Outdoors* and has had eighteen years' experience in studying, testing, and experimenting with firearms. He has kept careful records and files of his work and has reproduced much of this information in his book.

Such chapters as, "The Cartridge Case, Its Development and Manufacture," "Primers," "The History of Black Powder," "The Manufacture and Use of Black Powder," "The History of Smokeless Powder," and others, at first glance may seem irrelevant material, but a time arrives in every handloader's work, if he stays at it for any considerable period, when such information becomes highly valuable.

The volume contains two chapters which did not come from the author's pen; namely, Chapter 31, "Shot Loads for Revolvers," written by Dr. J. G. Kirk of Listowel, Ont., and Chapter 36, "Making Muzzle-Loaders Perform," by E. M. Farris. The inclusion of these two chapters indicates that where the author did not feel he had the necessary experience to handle the subject, he sought those who were qualified; thus he has given the handloading fraternity some of the best information obtainable.

The opinion may be formed, in first glancing through this book, that handloading is an expensive art requiring the outlay of considerable sums of money for tools, gages, etc. The author shows, however, that good work can be done and is being done with ordinary tools, and that as the operator gains more experience and expands his reloading activities, he will add the tools which are needed. There is no doubt that the saving effected by the use of reloading cartridges is nullified by the purchase of the necessary reloading equipment, but the pleasure afforded by this interesting hobby is ample compensation. H. E. S.

MOLYBDENUM IN STEEL. New York: Climax Molybdenum Company.

THIS is a comprehensive treatise on the properties, application, and uses of molybdenum. Its format and content will delight the eye and answer the query of the metallurgist in search of the right answer. The principal sections of the book are devoted to the general qualities of the metal and the various alloys: chromium-molybdenum; nickel-chrome-molybdenum; nickel-molybdenum; carbon-molybdenum; manganese-molybdenum; silicon-molybdenum and chromium-silicon-molybdenum.

There also are chapters on steels for elevated-temperature service; corrosion-resistant alloys; nitriding steels; molybdenum die high-speed and cast steels. And finally there is a complete index. Graphs and charts prepared by the company's engineers are used freely. All in all, this handbook tells the story of molybdenum in handy reference form as completely and readily as the most fastidious executive or hard-boiled engineer possibly could want it. The men who put the material together are to be congratulated as is the company that issued it. O. E. D.